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Proposal of a new framework for Project Management in a logistics department of an automotive company, applying Lean Thinking principles

Master Dissertation

Integrated Master's in Industrial Management and Engineering

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ABSTRACT

The current master thesis was developed at Bosch Portugal Car Multimedia S.A., in Braga, with the main goal of proposing a new framework for project management in a logistics department, using Lean Thinking principles.

In complex and dynamic business environments, it is important to become more effective and have more flexibility to changes. For that reason, organizations must adopt a project-based management to be increasingly competitive. This research was developed in a logistics department, which main work is sustained by innovation projects applied to the logistics. In order to maximize the project's success, this research was carried out, whose output is a framework for the management of projects adapted to the operations of the department. To support this research the author also carried out a systematic literature review.

In parallel, the author was integrated in the work environment, adopting an action research methodology to develop the framework and to eliminate the current waste associated to project management. Firstly, the diagnosing phase was performed. At this phase the current framework was analyzed and a round of semi-structured interviews with the project managers were carried out, to identify the problems. The list of identified problems was divided into several groups, but it was possible to highlight the time scheduling problem, the lack of information share between stakeholders and the inexistence of a proper deployment phase. Then, on the action planning phase, the new framework and some auxiliary documents used as standards were proposed to solve the problems identified. The final step was the implementation of the proposal, which is a cycle procedure with several improvements during the implementation. The final framework brought new activities and it is capable to adapt to the context of each specific project, minimizing waste and eliminating the problems that were identified earlier. The main results obtained were mostly related to the applicability of a new framework adapted to the department characteristics, which solved about 83% of the identified problems.

KEYWORDS

Project Management; Lean Thinking; Framework.

RESUMO

A presente tese de mestrado foi desenvolvida na Bosch Portugal Car Multimedia S.A., em Braga, com o objetivo principal de propor uma nova estrutura para a gestão de projetos no departamento de logística, utilizando princípios de *Lean Thinking*.

Em ambientes de negócios complexos e dinâmicos, é importante ser cada vez mais eficaz e ter mais flexibilidade para as rápidas mudanças do mercado. Por essa razão, as organizações devem adotar uma gestão baseada em projetos com o intuito de serem cada vez mais competitivas. Esta pesquisa foi desenvolvida num departamento de logística, cujo principal trabalho é sustentado por projetos de inovação aplicados à logística. A fim de maximizar o sucesso destes projetos, esta pesquisa foi realizada, cujo resultado é uma *framework* para a gestão de projetos adaptada às operações do departamento. Para apoiar esta investigação, o autor realizou uma revisão sistemática da literatura. Em paralelo, o autor foi integrado no ambiente de trabalho, adotando uma metodologia de investigação-ação, para desenvolver a metodologia e eliminar os desperdícios atuais inerentes à gestão de projetos. Primeiramente, foi realizada a fase de diagnóstico. Nesta fase, o estado atual foi analisado e foi realizada uma ronda de entrevistas semiestruturadas com os líderes de projetos, para identificar os problemas. A lista de problemas identificados foi dividida em vários grupos, mas foi possível destacar o problema de cumprimento da calendarização, a falta de partilha de informações entre os interessados e a inexistência de uma fase de implementação adequada. Em seguida, na fase de planeamento de ações, a nova metodologia e alguns documentos auxiliares utilizados como padrão foram propostos para solucionar os problemas identificados. A etapa final foi a implementação da proposta, que é um procedimento em ciclo com várias melhorias durante a implementação. A metodologia final introduziu novas atividades e é capaz de se adaptar ao contexto de cada projeto específico, minimizando o desperdício e eliminando os problemas que foram identificados anteriormente. Os principais resultados obtidos relacionaram-se essencialmente com aplicabilidade da nova metodologia para as características do departamento, que resolveu cerca de 83% dos problemas identificados.

PALAVRAS-CHAVE

Gestão de Projetos; Pensamento Lean; *Framework*.

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List of Abbreviations and Acronyms

CM - Car Multimedia

ERP - Enterprise Resource Planning

IoT - Internet of Things

LOG - Logistics

LOI - Logistic of Innovation

LPM – Lean Project Management

SLR - Systematic Literature Review

VSM - Value Stream Mapping

1. INTRODUCTION

This chapter presents the background and motivation for this dissertation project. Therefore, in this section, the objectives are identified, the research methodology is presented, and the dissertation structure is shown.

1.1 Context and motivation

For thousands of years, participation in various kinds of projects has been a complement to the eternal struggle for food and a roof over one's head. Constructing pyramids, discovering the New World, crowding the shores of Dunkirk with Allied soldiers, the history books are full of unique, complex undertakings, limited in time and scope. Business activities have also often been organized as projects. Craftsmen and ship-owners have always offered unique products for unique purposes (Packendorff, 1995). Nowadays, with a substantially competitive world, the importance of having an optimized strategy to apply to projects is tremendously high. The business environment is dynamic with an accelerating rate of change. To remain competitive in the world economy, companies are embracing project management to consistently deliver business value (Project Management Institute, 2017).

Project management can be defined as the process of controlling the achievement of the project objectives (Dai, 2001). Project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. It is accomplished through the appropriate application and integration of the project management processes identified for the project (Project Management Institute, 2017). These project management processes are essential to the development of a successful project, thus this dissertation took in consideration the Lean Thinking principles application in order to improve project management processes and interactions.

Since the 1950s, Lean production has evolved and were successfully implemented (Aziz & Hafez, 2013). Several years later Womack and Jones studied this system and started calling the philosophy behind the system: Lean Thinking (Wilson, 1997). Lean Thinking is the antidote to waste. It is a philosophy to achieve more with less (Jalali, Hertogh, Bosch-rekveldt, & Blom, 2016). This philosophy has five principles which are the identification of value, the mapping of the value stream, the creation of a flow, the establishment of pull production and the pursue of perfection (Womack & Jones, 1996). The first principle means that value is always

defined by the customer's needs for a specific product. Value can be defined only by the ultimate customer. It specifies the important requirements or expectations that must be met (Womack & Jones, 1996). The second principle, the value-stream mapping is a simple experience that identifies all the actions that take a product or service through any process. After the waste has been removed from the value stream, the next step is to be sure the remaining steps flow smoothly with no interruptions, delays, or bottlenecks, and that is the third principle. The next principle, the establishment of pull, is deeply connected to the production, where the costumers pull the products, preventing the increase of stocks. The fifth step is, perhaps, the most important, making Lean Thinking and process improvement part of a corporate culture.

These principles have been applied to Project Management to improve this process, increasing value by reducing waste. This application has been called Lean Project Management (LPM) (Moujib, 2007) and, when well applied, introduces a disciplined way for teams to develop projects, stimulating an environment of innovation. As a central element in the process of innovation, project management has become a key activity in most industrial organizations and across many industries (Shenhar & Dvir, 1996). Research into project management continues to change, a phenomenon which can be attributed to developments in the body of knowledge, but also to the multi-disciplinary nature of the field, and the expansion of project management into new practice domains (Pollack & Adler, 2015).

Another development in project management was the introduction of agile project management. The Agile approach was developed in the software industry, but many other industries have also adapted the agile approach. Agile aims to increase the relevance, quality, flexibility, and business value of software solutions (Jalali et al., 2016).

It is because of this variety of approaches and fields of research in this area that the work developed, and the framework proposed, during this research, took in consideration, not only an approach to projects, but also several tools from other fields to improve project management processes.

This project was developed in an electronic components company, Bosch Car Multimedia, Portugal S.A. This master thesis took place in Braga, in the CM/LOI-Brg (Logistics Innovation) department, which is a central department that has his scope of work in all CM associates. It also coordinates projects and gives support to various areas of logistics. Today, project

management is implemented in the organization but varies in its details by organizational units. Each function has an individual approach regarding process, glossary, training, and project management organization, so tailoring concerns were taken into consideration.

1.2 Objetives

The main objective of this research was to propose a new framework for project management, applying Lean Thinking principles in a logistics department of Bosch Car Multimedia. In order to achieve this main objective, it was necessary to:

- Identify all past and undergoing processes for project management;
- Map these processes;
- Develop a standardized framework for project management processes;
- Implement the framework for ongoing and for future projects.

With the accomplishment of the main objective, it was expected to:

- Instill project management processes;
- Improve the planning of workloads for team members or stakeholders;
- Reduce time wastes on the development of projects;
- Improve the scope output, budget traceability and schedule planning on each project;
- Improve the overall quality of the projects;
- Define the roles and responsibilities for project management;
- Use of the same standards among all the projects.

1.3 Research methodologies

This section presents the two different methodologies of research that were used. The first one is the procedure that is behind the process of construction of the Systematic Literature Review (SLR). Oates and Capper (2009) say that a SLR aims to provide an explicit, rigorous, reproducible, and auditable process for evaluating and interpreting all available research, relating to a particular research question, topic, area, or phenomenon of interest. It is for this reason that a systematic literature review was conducted (see chapter 2). The other one is

about the main point of the study called the Action Research Methodology, in which all the steps are described in order to achieve the main goals of the thesis.

1.3.1 Systematic Literature Review

To support the research developed in this master dissertation it was decided to undertake a Systematic Literature Review (SLR) about project management methodologies and related topics. With this, the author intended to deepen the knowledge about this topic. At the same time, the author wanted to highlight important methodologies that could help in the design of the methodology developed in this dissertation.

The main findings, conclusions and discussions of the SLR of this specific study are presented in section 2.2. The SLR development aspects, as well as the research questions that guided the study, are presented in this section.

The literature review consists of a theoretical background on which the main topics are presented separately and the critical analysis and discussion relating the main topics.

As so, a SLR is a form of secondary study that uses a well-defined methodology to identify, analyze and interpret all available evidence related to a specific research question (Nurdiani, Börstler, & Fricker, 2016). The SLR methodology that was used consists on a three-step procedure for data collection, choice criteria and data selection, to provide whatever is necessary to achieve the main goal of this research. This three-step procedure consists of:

1. Defining the appropriate research questions: The process began with the choice of the literature field, which was targeted for this research. Since the scope was defined, the next action was the choice of adequate research questions. This was one of the most important steps, insofar as these questions act as success criteria for the screening that happened further ahead;
2. Defining appropriate search terms: Firstly, it was important to assure the inexistence of studies of this kind, for the same scope. Then a keyword assembly structure that aims to accommodate a broad range of search terms was defined;
3. Process of screening and data selection: Using the success criteria, the last step consist in successive rounds of screening until the list of articles is complete. In the end, a statistical analysis was also done.

These three steps, as well as the sub-tasks of each, are described in a process diagram format (Figure 1).

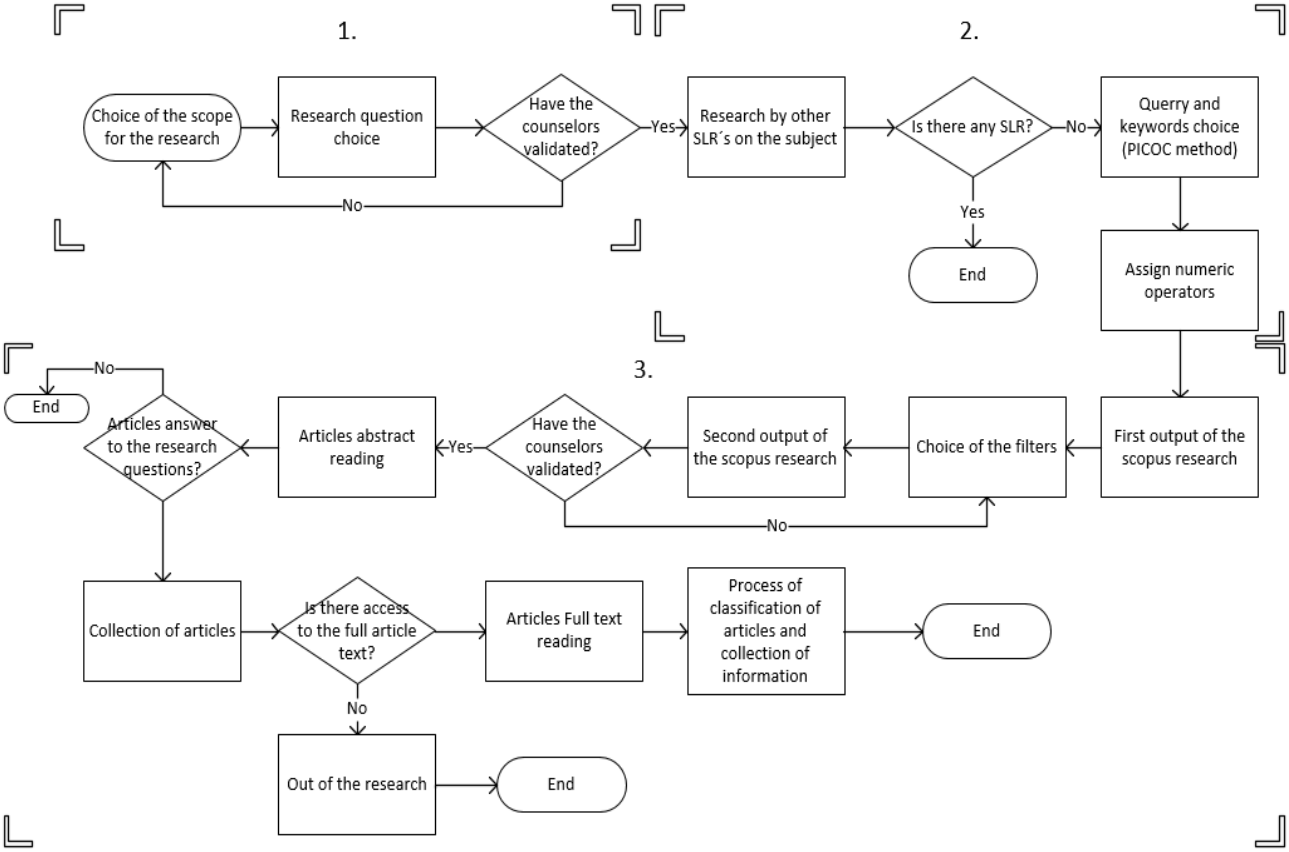

Figure 1 - Systematic Literature Review procedure

1.3.2.1 Research question

According to Tranfield et al. (2003) a SLR aims to map and evaluate the body of literature and identify potential research gaps highlighting the boundaries of knowledge. Hence, a set of research questions was defined to assess the state of art on the topic of the project management - traditional and agile approaches - applying Lean Thinking principles:

1. What is the relation between Lean Thinking and Project Management?
2. What project management methodologies were found on this research?

The research questions presented above have a strong relationship with the exclusion criteria, which is responsible for the process and of scanning the papers.

1.3.2.2 Previous literature reviews on the theme

Although it is common to find these types of studies, at the time of this research there was no SLR specifically within the scope of this study. It is important to say that uncountable SLR´s about the addressed themes like “project management” or “agile methodologies” were found, however the scope of them was always different from this one.

1.3.2.3 Keyword search and scope definition

The search terms were built in a multi-level keyword assembly structure that aims to accommodate a wide range of search terms and fields. This search was inspired on the PICOC structure (Population, Intervention, Context, Outcome and Comparison) as recommended by Schultz and Schultz (2014). The PICOC structure served as base for some fields of the keyword assembly, namely the Population, Intervention and Context. The main level called “Population” defines the search context (Project management), the second layer of the search is divided in three different areas named as “context 1, 2 and 3”. The purpose of the context is to allow a deep search on important areas that are attached to the search context. The final level was inspired in Silva et al. (2010), and it is the “Intervention” terms of research. The result of this process is in Table 1.

Table 1 - Research Keywords

Population	Project Management	Main Field
Context 1-Lean	(lean OR "Process improv*" OR "Continuous improvement" OR kaizen OR kanban OR jit OR "5S " OR jidoka OR standardization OR heijunka OR pul l OR "Visual system" OR triz OR "six sigma" OR "Lean green" OR "Lean green" OR tpm OR smed OR levelling OR leveling OR "Simultaneous lean" OR tqm OR "Lean manag*")	Keywords to cover the Lean thinking field
Context 2 - Agile	(agile OR agility OR scrum OR " XP" OR "extreme programming" OR FDD OR "feature-driven development" OR "feature-driven" OR "Dynamic Systems Development Method" OR DSDM OR "Adaptive Software Development" OR "ASD" OR "Crystal and Rational Unified Process" OR "RUP" OR TDD OR " test-driven development" OR "test-driven")	Keywords to cover the Agile field
Context 3 - PM fields	("Cost manag*"OR "Quality manag*"OR "Risk manag*" OR "Procurement manag*" OR "Stakeholder* manag*")	Keywords to cover the field

Intervention terms -	(model* OR process* OR framework* OR method* OR technique* OR methodolog* OR t ool* OR program* OR system* OR practice* OR ad option OR tailor* OR "Case stud*")	Intervention words

Another important aspect is the definition of the logic operators, which is important to define the scope of the research. Specifically, the logic behind this study is **"Population AND (Context 1 OR Context 2 OR Context 3) AND Intervention"** as it is possible to see in Figure 2.

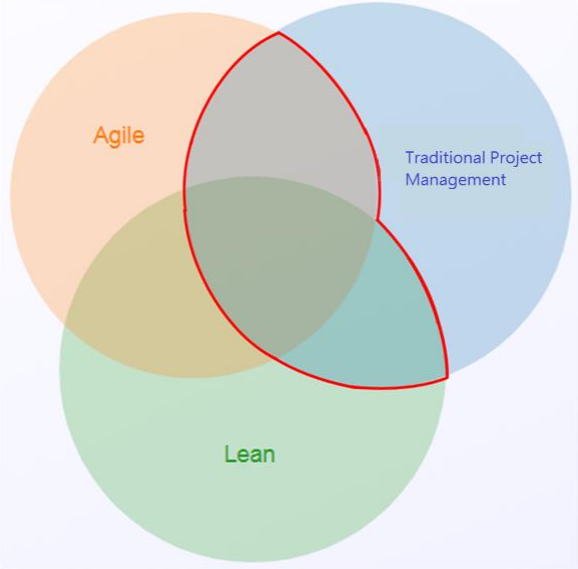

Figure 2 - Literature scope

1.3.2.4 Database output

The following step is the choice of filters for the keywords, otherwise the number of results of the research would not be reasonable. The first research had as output **3511** papers. Therefore, the research that was conducted in the Scopus database was made with the keywords presented in Table 1, but using the "title, abstract" search, for articles from journals, that are written in English and with a time restriction (1st January 2000 to 28th January 2019). This reduced the raw data to **1085** papers, which served as base for the literature analysis.

The filtering procedure that was used has four different and intercalated main steps. From the moment that the first sample, with 1085 papers, was in an excel file, the reviewing

methodology begun. The first step was to verify if there was any repeated paper. From that sample, it was necessary to read the abstracts of the papers and exclude the ones that fulfilled the exclusion criteria. The exclusion criteria follow the same line of thinking of the research questions. The articles that apparently seemed to answer at least one of the questions, or even bring something innovative to the field of project management frameworks, were considered. At this time, the sample had **151** papers. Every article on that list of 151 was read, allowing to understand which articles had passed wrongly through the screening phase. Then, **80** articles had something relevant to add on the research, however, at the end, only **30** were selected for the discussion of the topics. The contribution of each one of the articles is in appendix 1.

Managed by Elsevier publishing, Scopus is the largest abstract and citation database of peer-reviewed research literature in the fields of science, technology, medicine, social sciences, and arts and humanities. It covers over 20,000 peer-reviewed journals including those published by Elsevier, Emerald, Informs, Taylor and Francis, Springer and Inderscience. The Scopus coverage details include access to tens of millions of peer re-viewed journal. The Scopus database is more comprehensive than the Web-of-Science database, which would include only ISI indexed journals, limited to 12,000 titles only. Since we are focusing on peer-reviewed journals, we found that the Scopus database would capture the most reputable international journals, some of which may be relatively new, but influential. For this reason, it was the only research database used.

The PRISMA methodology (*Preferred Reporting Items for Systematic Reviews and Meta-Analysis*) described in Moher et al. (2009) served as base to what was described above. In Figure 3 it is possible to identify the procedure.

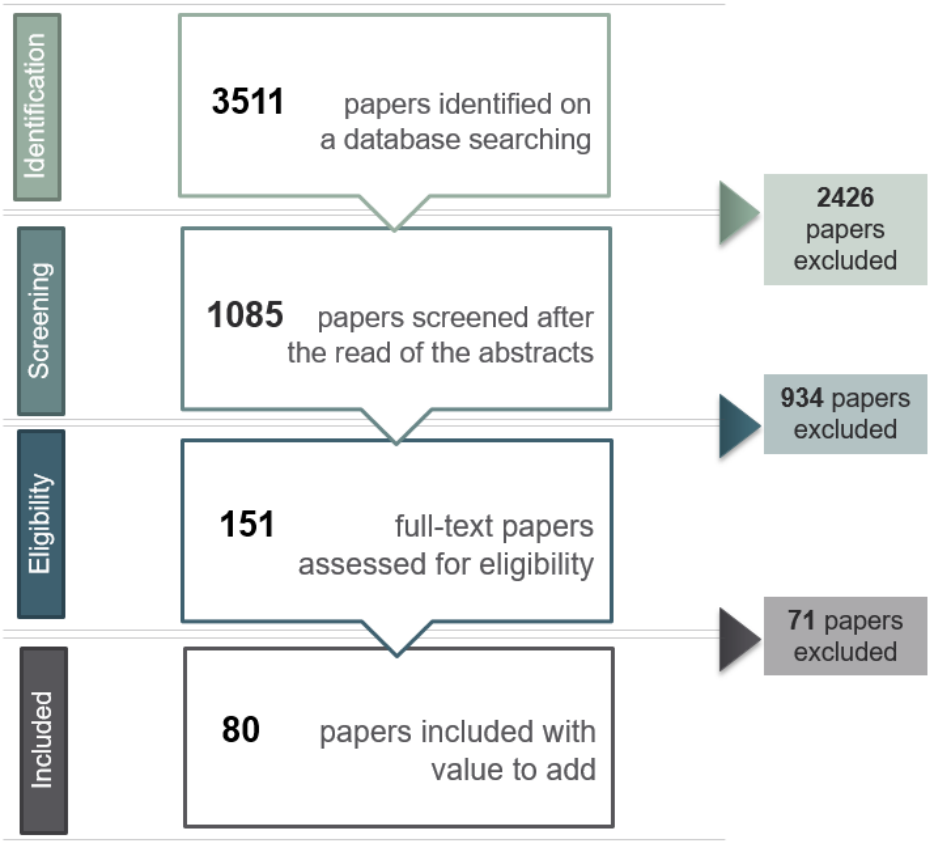

Figure 3 - Prisma Methodology

1.3.2.5 Bibliometric Analysis

A keywords-based bibliometric analysis on both the initial (1085 papers) and final (80 papers) samples were performed to better understand what keywords were used on this search. The bibliometric analysis performed to the initial sample reveals that the main keyword by far is "project management", however, the remaining keywords cover a wide range, which demonstrates the heterogeneity of the search area. On the other hand, the analysis of the final sample gives an idea that the most important keywords previously found are the same at the end of the search, enabling the validation of the content analysis performed in order to refine the initial sample of 1085 (Figure 4) papers into 80 papers (Figure 5).

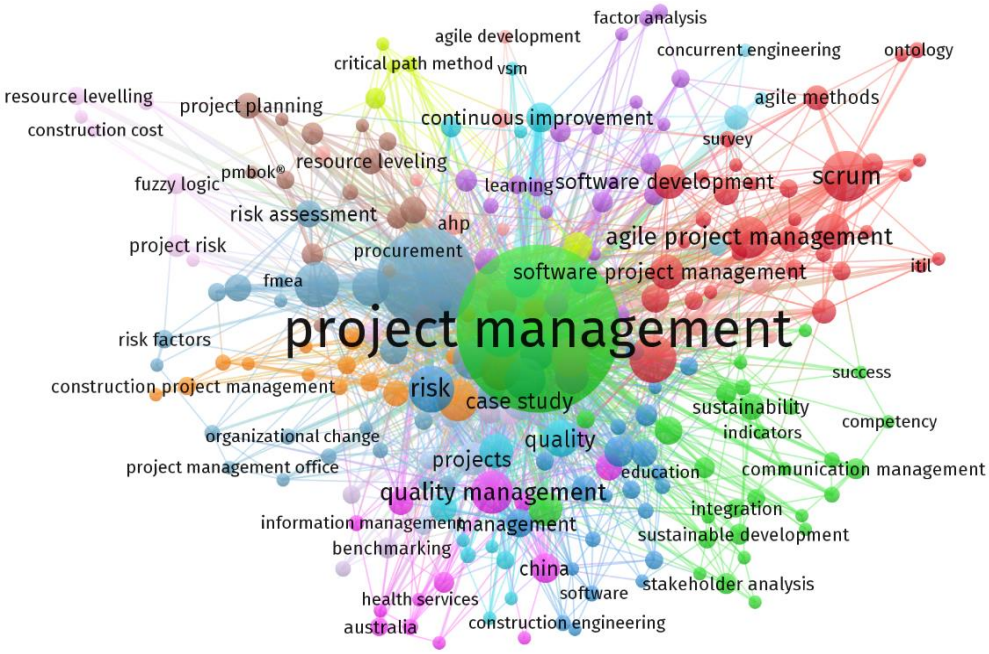

Figure 4 - Bibliometric analysis 1

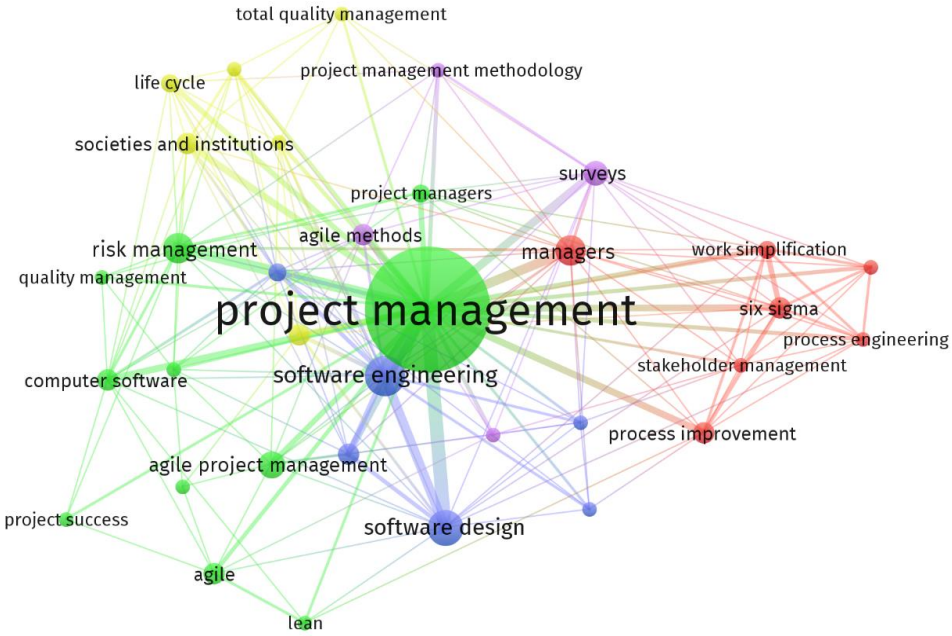

Figure 5 - Bibliometric Analysis 2

1.3.2 Action Research Methodology

Most research textbooks represent research as a multi-stage process that a researcher must follow in order to undertake and complete a research project. The precise number of stages varies, but they usually include formulating and clarifying a topic, reviewing the literature, designing the research, collecting data, analyzing data and writing up (Saunders, Lewis, & Thornhill, 2017).

The research philosophy is related to the development and the nature of the knowledge. The research philosophy that is going to be used is the pragmatism. Pragmatism is a philosophy where either or both observable phenomena and subjective meanings can provide acceptable knowledge, dependent upon the research (Saunders, Lewis, & Thornhill, 2009).

Deductive approach can be explained by the means of hypotheses, which can be derived from the propositions of the theory. In other words, deductive approach is concerned with deducting conclusions from premises or propositions. It has been stated that deductive means reasoning from the general to the particular.

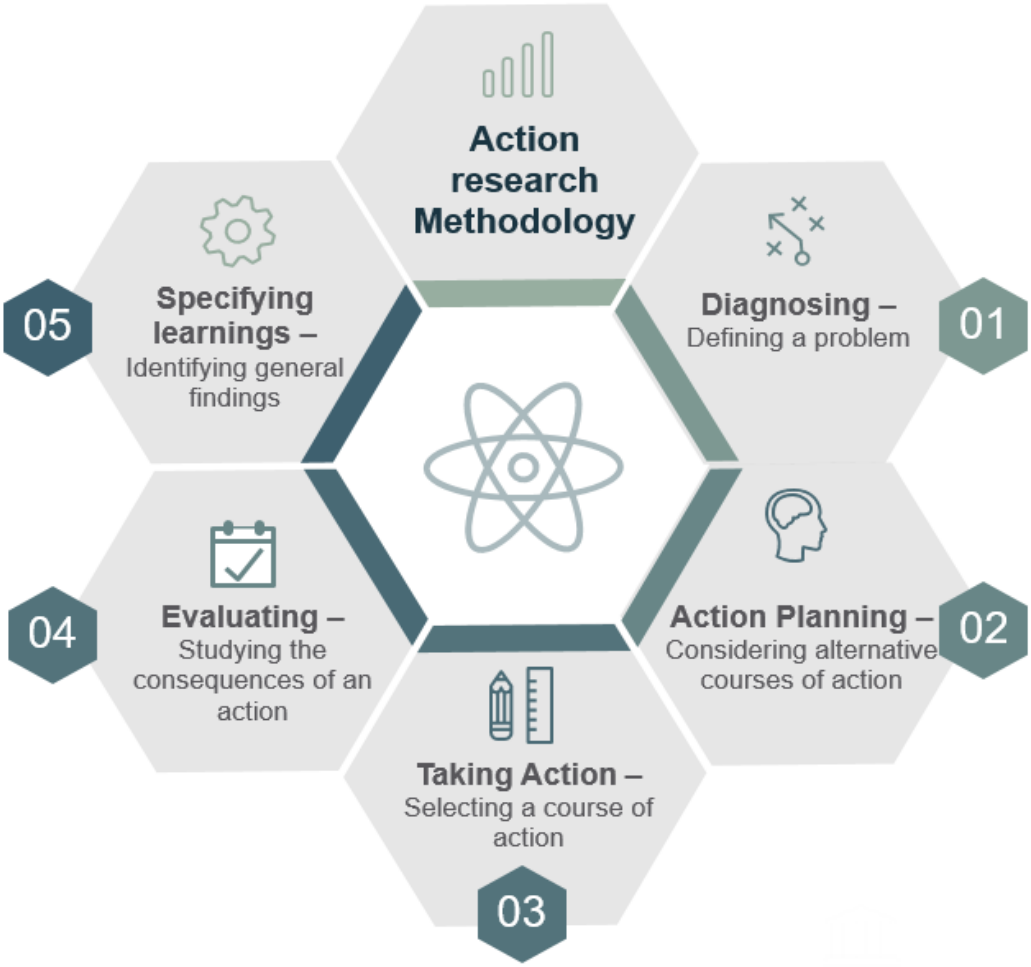

Figure 6 - Action Research Methodology
Based on O'Brien (1998)

The research strategy used was the action research. Action research is a disciplined process of inquiry conducted by and for those taking the action. Action research combines theory and practice through change and reflection, in an immediate problematic situation, within a mutually acceptable ethical framework. Action research is an iterative process involving researchers and practitioners acting together on a particular cycle of activities, including problem diagnosis, action intervention, and reflective learning (Avison, Lau, Myers, & Nielsen, 1999). In action research, the researcher wants to try out a theory with practitioners in real situations, gain feedback from this experience, modifying the theory as a result of this feedback, and trying it again (Avison et al., 1999).

The project followed the five steps that the action research methodology describes. Those steps are described in Figure 6, and more specifically, with the activities developed in each step of Figure 7.

The first step of the approach, the Diagnosing phase, focused on the existent framework analysis and on the identification of problems. The existent framework for project management had some problems, which led to its abandonment. Consequently, the abandonment of a framework for the management of projects brought other problems related to the management of projects. At this section, tools as flowcharts, fishbone diagrams, semi-structured interviews, were considered. Once the framework was dissected, and the problems found, there was time to the development of the assessment chart study, in which the agility degree for the framework was identified (Figure 7).

The second step is defined as the action planning phase, in which a series of events are planned in order to prepare the next phase. At the same time a massive intern and external research about the main theme was done. The proposal needs to take in consideration all the problems, and issues that were raised at the previous step. Then the formal presentation of the new framework of project management took place.

The third phase is the taking action phase and it was the implementation of the framework on some ongoing projects.

As it is said in O'Brien (1998), much of the researcher's time is spent in refining the methodological tools to suit the requirements of the problem, systematically, and ensure the intervention is informed by theoretical considerations. Much of the researcher's time was spent on refining the methodological tools to suit the requirements of the situation, and on collecting, analyzing, and presenting data on an ongoing and cyclical basis. That means that it is an iterative process, and those improvements dwell on the fourth phase (Evaluating phase). Furthermore, it is also time to analyze the results and the outcomes of this iterations.

Finally, the final phase consists on specifying the learnings, where lessons learned were registered and the next steps were discussed in order to implement the framework. Unfortunately, and due to the lack of time, it was not possible to implement the framework.

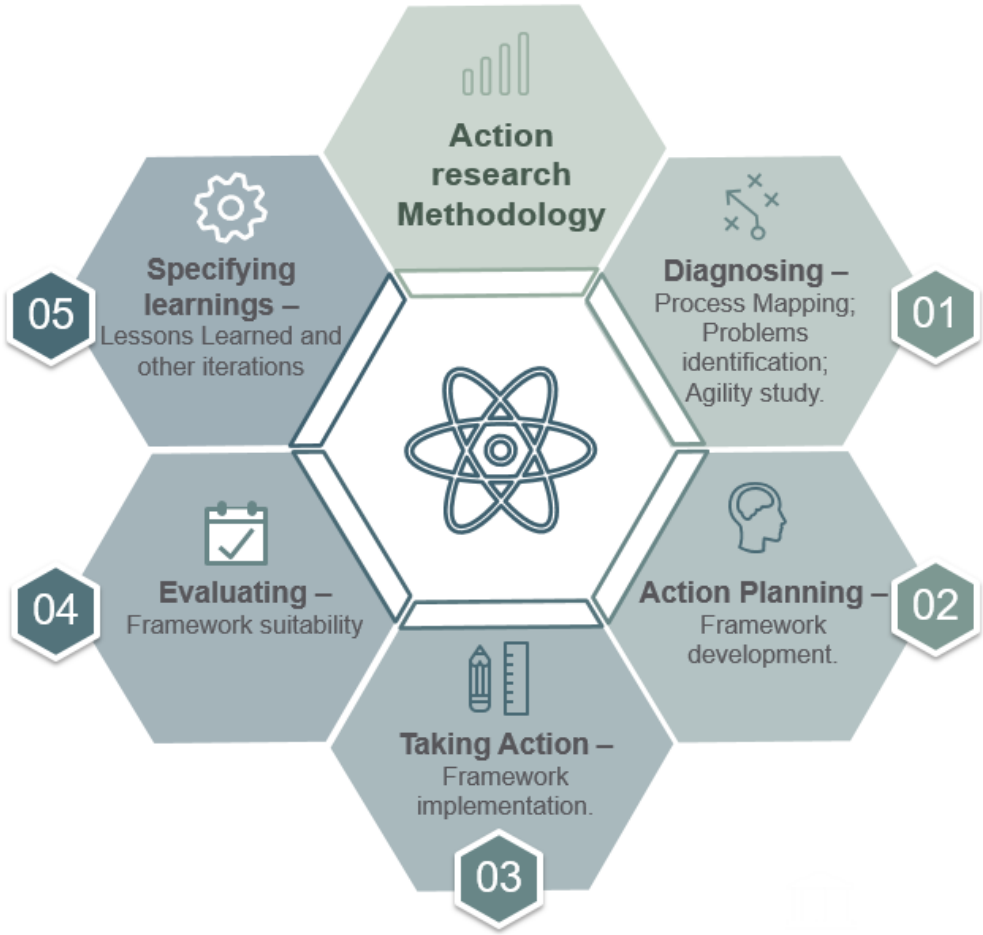

Figure 7 - Action research applied to this study

1.4 Structure of the document

This dissertation is divided into seven different chapters. The first is where this sub-chapter is inserted, the introduction of the dissertation, that is, where the background is described, the objectives identified, and the research methodology used presented.

The second chapter presents a Systematic Literature Review (SLR) of the main topics addressed in this dissertation, being the scope the field of the literature that combines Project

Management, Lean Production, Lean Project Management, Agile Methodologies and Hybrid Methodologies.

The company where this dissertation was developed is presented in the third chapter. The main history landmarks are identified and the company's journey around the world acknowledged. After that, the level of detail starts to increase, deepening to the department in which the dissertation was inserted.

The fourth chapter is the description and critical analysis of the department and the problems identified, taking into consideration the data gathered and all the needs, in order to meet the proposal specifications. To solve the identified problems, the improvement measures are described in chapter five. In chapter six, the results obtained with the implemented measures are quantified and analyzed. Lastly, chapter seven presents the conclusions of the research and the proposals for future work.

2. SYSTEMATIC LITERATURE REVIEW

In this chapter, it is intended to present the Systematic Literature Review and the state of art of the topics and theories that are on the foundation of this research. Therefore, this chapter is divided into Project Management (traditional approach), Lean Production, Lean Project Management, Agile Methodologies and Hybrid Methodologies, which are the theoretical background of the study. The chapter ends with the main results of the SLR, which procedure was described on the section 1.3.1.

2.1 Theoretical background

This section presents a brief theoretical background of the concepts that sustain the research undertaken in this dissertation, namely, Project Management, Lean Production, Agile Methodologies and Hybrid Methodologies.

2.1.1 Project Management

The project management knowledge takes an important role on this research, being one important keyword also. Project management definition, PMBOK overview and strategies are succinctly described next.

2.1.1.1. Definition

According to multiple empirical studies, a company's effectiveness partly depends on the success of its projects (Milosevic & Patanakul, 2005) as it is said on Griffiths (2004).

As Turner (2008) stated, "project management is about converting vision into reality". When an individual or group has a vision of some future state they would like to achieve, project based management is the structured process by which that future state is successfully delivered (Turner, 2008). According to Project Management Institute (2017), a project is a temporary endeavor undertaken to create a unique product, service, or result, whereas IPMA (2015) say that a project is a time and cost constrained operation to realize a set of defined deliverables (the scope to fulfill the project's objectives) up to quality standards and requirements.

2.1.1.2. PMBOK Overview

The Project Management Institute (PMI) defines the Project Management Body Of Knowledge (PMBOK) as a term that describes the knowledge within the profession of project management. The project management body of knowledge includes proven traditional practices that are widely applied as well as innovative practices that are emerging in the profession (Project Management Institute, 2017).

The PMBOK was chosen for this research, not only because it is the standard guide used by the company, but also because it covers several areas of knowledge, and it is considered a great source of knowledge.

The Project Management Institute was formally incorporated in Commonwealth of Pennsylvania in 1969 with five volunteers in the field of project management working together to "advance the practice, science and profession of project management".

PMBOK® Guide is an acronym for "A Guide to the Project Management Body of Knowledge" and it is the most important publication by the PMI.

After extensive consultation and revision, the PMBOK® Guide was published in 1996 to supersede the previous documents. They saw a need to put together an official document and guide to advance the development of the project management profession. This was known as the PMBOK® Guide 1st Edition. Since then the PMI has been improving the methods developing five more Guides - PMBOK® Guide 2nd Edition [2000], PMBOK® Guide 3rd Edition

[2004], PMBOK® Guide 4th Edition [2009], PMBOK® Guide 5th Edition [2013] and PMBOK® Guide 6th Edition [2017].

According to the 6th Edition of the PMBOK (Project Management Institute, 2017) , a project life cycle is the series of phases that a project passes through from its start to its completion. A project phase is a collection of logically related project activities that culminates in the completion of one or more deliverables. The project management processes -Figure 9- can be divided into five groups of processes, which are:

- **Initiating Process Group.** The process performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.
- **Planning Process Group**. The process required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.
- **Executing Process Group.** The process performed to complete the work defined in the project management plan to satisfy the project requirements.
- **Monitoring and Controlling Process Group.** The process required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.
- **Closing Process Group.** The process performed to formally complete or close a project, phase, or contract.

These five groups of processes characterize a project life cycle and interact with each other, as shown in Figure 8.

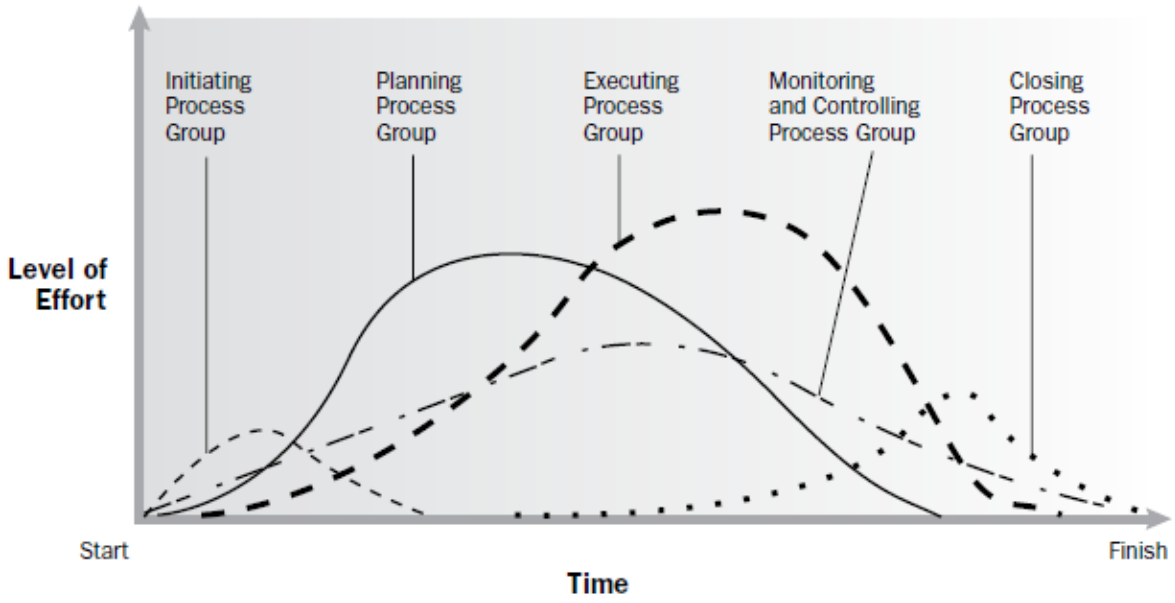

Figure 8 - Process Group Interactions within a Project or Phase
Adapted from Project Management Institute (2017)

Regardless these five group processes, PMBOK (Project Management Institute, 2017), also establishes ten areas of knowledge for Project Management, which are:

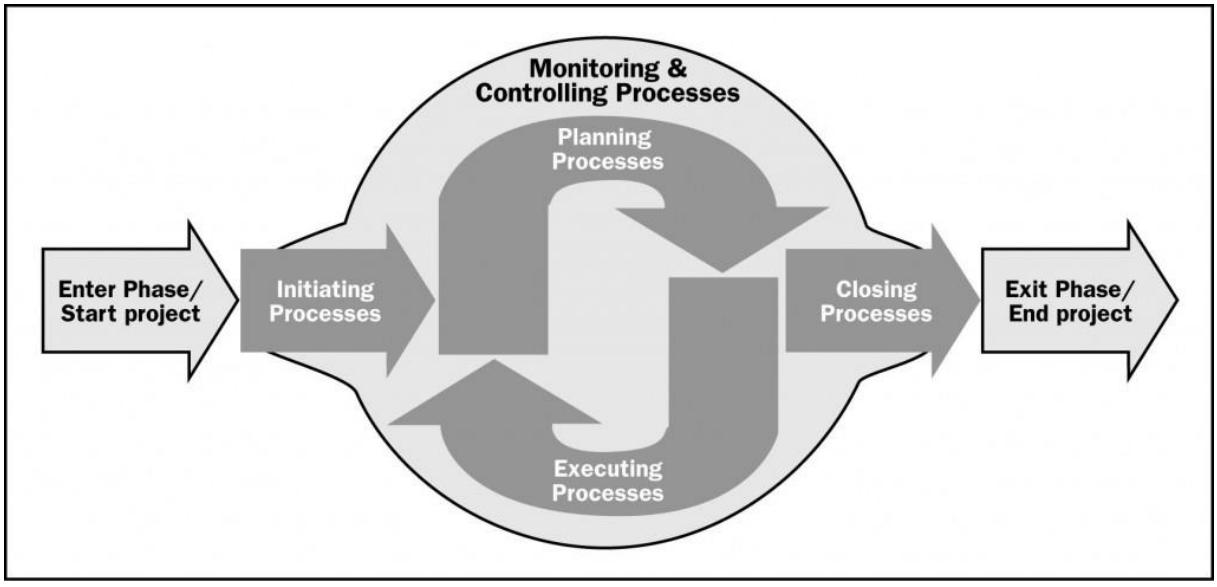

Figure 9 - Process groups
Adapted from Project Management Institute (2017)

- **Project Integration Management** - includes the processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups. Rehacek (2017) also said that Integration describes the processes required for project coordination.

- **Project Scope Management** - includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully.
- **Project Schedule Management** - includes the processes required to manage the timely completion of the project.
- **Project Cost Management** - includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs, so the project can be completed within the approved budget.
- **Project Quality Management** - includes the processes for incorporating the organization's quality policy regarding planning, managing, and controlling project and product quality requirements, in order to meet stakeholders' expectations.
- **Project Resource Management** - includes the processes to identify, acquire, and manage the resources needed for the successful completion of the project.
- **Project Communications Management** - includes the processes required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and ultimate disposition of project information.
- **Project Risk Management** - includes the processes of conducting risk management planning, identification, analysis, response planning, response implementation, and monitoring risk on a project.
- **Project Procurement Management** - includes the processes necessary to purchase or acquire products, services, or results needed from outside the project team.
- **Project Stakeholder Management** - includes the processes required to identify the people, groups, or organizations that could affect or be affected by the project, to analyze stakeholder expectations and their impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in project decisions and execution.

A summary of the project management process groups and its connection with the knowledge areas is represented in Table 2.

Table 2 - Project Management Process Group and knowledge Area Mapping
(PMI, 2017)

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	**Planning Process Group**	**Executing Process Group**	**Monitoring and Controlling Process Group**	**Closing Process Group**
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work 4.4 Manage Project Knowledge	4.5 Monitor and Control Project Work 4.6 Perform Integrated Change Control	4.7 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Schedule Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Durations 6.5 Develop Schedule		6.6 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Manage Quality	8.3 Control Quality	
9. Project Resource Management		9.1 Plan Resource Management 9.2 Estimate Activity Resources	9.3 Acquire Resources 9.4 Develop Team 9.5 Manage Team	9.6 Control Resources	
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Monitor Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses	11.6 Implement Risk Responses	11.7 Monitor Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Engagement	13.3 Manage Stakeholder Engagement	13.4 Monitor Stakeholder Engagement	

2.1.1.3. Strategies

Project management is a field with great support of published knowledge, and the number of methodologies, due to the nature and scope of each project, is tremendously high. However, those methodologies are based on different project management strategies.

Wysocki (2006) defined as project landscape variables the complexity and the uncertainty. These two variables are the foundation that lead to the development of the strategies that are going to be presented next.

- **Linear strategy**

Until the early 1990s this was the overwhelming choice of software developers. A Linear strategy is a traditional strategy that consists of dependent, sequential phases that are executed with no feedback loops. The project solution is not released until the final phase (Fernandez, Daniel & Fernandez, John, 2009). A more traditional approach, with the bulk of planning occurring upfront, then executing in a single pass, a sequential process (Project Management Institute, 2017) (Figure 10).

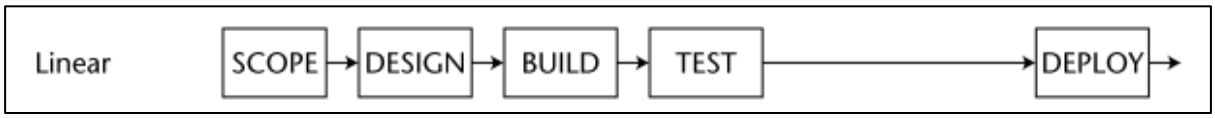

Figure 10 - Linear Strategy
(Wysocki, 2006)

- **Incremental Strategy**

An Incremental strategy consists in a number of dependent phases that are repeated in sequential order. Incremental approaches must meet the same requirements as linear approaches. The goal and the solution must be clearly defined and the approach is chosen so that results can be delivered in stages over the life of the project (Wysocki, 2009).

The goal and solution must be clearly defined and documented as a condition for using the models like the Staged Delivery Waterfall model, and the Feature-Driven Development model. These are two examples of incremental approaches and both models require the complete documentation of requirements, functionality and features. It is an approach that provides finished deliverables that the customer may be able to use immediately (Figure 11).

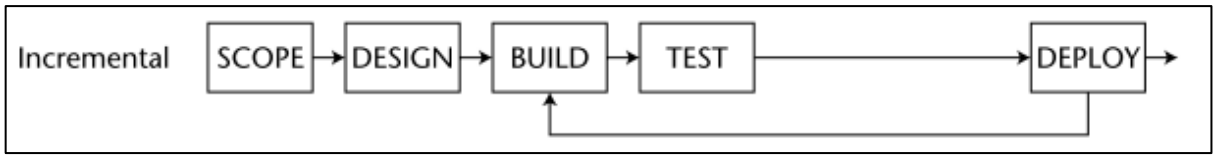

Figure 11 - Incremental Strategy
(Wysocki, 2006)

- **Iterative strategy**

It has a number of phases that are repeated in groups with a feedback loop after each group is completed. The Iterative strategy is a learn-by-doing strategy that uses intermediate solutions as a pathway to discover the details of the complete solution (Fernandez, Daniel & Fernandez, John, 2009).

The most known iterative approaches are the Evolutionary Development Waterfall model, the SCRUM methodology, the Rational Unified Process (RUP) and the Dynamic Systems Development Method (DSDM) (Wysocki, 2006).

Iterative life cycles improve the product or result through successive prototypes or proofs of concept. Each new prototype yields new stakeholder feedback and team insights. Then, the team incorporates the new information by repeating one or more project activities in the next cycle. Teams may use time boxing on a given iteration for a few weeks, gather insights, and then rework the activity based on those insights. In that way, iterations help identify and reduce uncertainty in the project (Project Management Institute, 2017) (Figure 12).

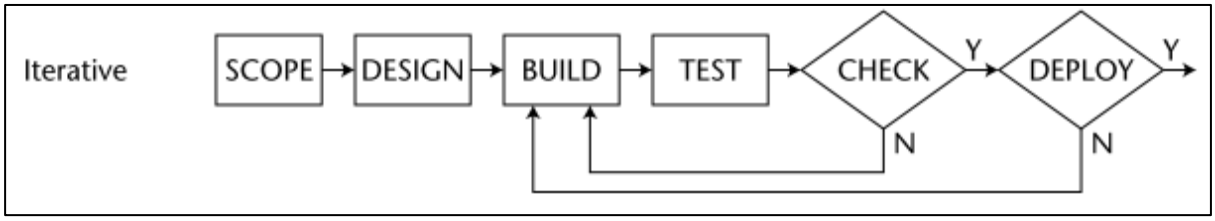

Figure 12 - Iterative Strategy
(Wysocki, 2006)

- **Adaptive strategy**

An Adaptive strategy is similar to an Iterative strategy except that with an Adaptive strategy each iteration's feedback adjusts the next iteration so that a solution will be converged upon. An iteration can release a partial solution at the discretion of the customer (Fernandez, Daniel & Fernandez, John, 2009) (Figure 13).

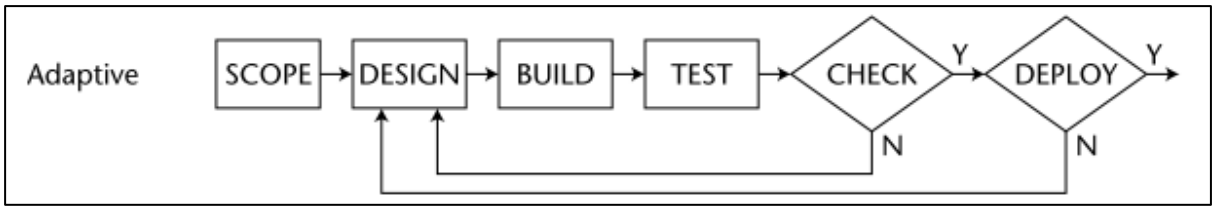

Figure 13 - Adaptive Strategy
(Wysocki, 2006)

- **Extreme strategy**

An Extreme strategy is similar to an Adaptive strategy except that instead of adjusting with each iteration to converge upon a solution, the goal of the project must also be discovered and converged upon. The lack of goal clarity is the main difference between the Adaptive and Extreme strategies. This type of project goal uncertainty is also referred to as "chaos" since "often the project ends up with final results that are completely different from the project's original intent" (De Meyer, Loch, & Pich, 2002) as cited in (Fernandez, Daniel & Fernandez, John, 2009) (Figure 14).

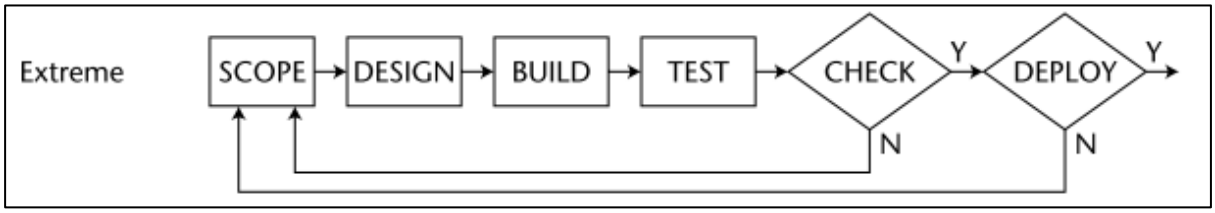

Figure 14 - Exteme Strategy
(Wysocki, 2006)

Figure 15 outlines the way that the different strategies interact with the variables of the uncertainty and the complexity.

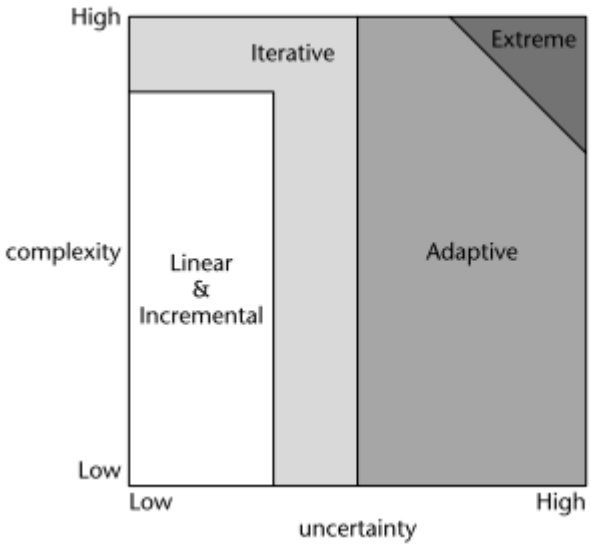

Figure 15 - The contemporary software development landscape
(Wysocki, 2006)

According to Fernandez, Daniel and Fernandez, John (2009) and from an agile project management classification perspective, the Iterative, Adaptive, and Extreme strategies fall under the agile project management umbrella (section 2.1.3).

2.1.2 Lean Production

This section presents a briefly introduction to Lean and its origin. In addition, Toyota Production System (TPS), and Lean Thinking principles are presented. Next, waste types and symptoms of waste are described.

2.1.2.1. The origin of Lean Production

According to Womack, Jones, & Roos (1990) , the word "Lean" represents a system that requires fewer inputs in order to create the same results as traditional mass production systems, while offering a wider range of products to the final customer. The term Lean Production may have different designations such as just-in-time manufacturing, synchronous manufacturing, world class manufacturing, or continuous flow.

The appearance of the Lean Production methodology is associated with the Toyota Motor Company. Lean Production is a management philosophy that implies "doing more with less", which means less effort, less space, less investment and fewer hours of new product development, which will require less time to be produced(Womack & Jones, 1996). It was the

term then used to define this new system of production much more efficient, agile, flexible and innovative than the mass production (Ohno, 1988).

In the mid-1950s, Taiichi Ohno and Toyota Motor Company engineers traveled to America to learn the concepts of "Mass Production" that Henry Ford would have implemented. During this time, they realized that Henry Ford's system was not ideal for what they intended. Although they were able to produce large quantities at low cost, there was no productive flexibility, thus exposing themselves to market variations. Taiichi Ohno and his engineers brought the concepts of the production line, but they had to think how to adapt to their reality: small quantities, productive flexibility and continuous production flow. This passage was a turning point in the history of Toyota Motor Company as well as in the history of industrial evolution. Taiichi Ohno founded the TPS - Toyota Production System.

TPS has 14 different principles (Liker, 2004), which are going to be presented next:

- Principle 1. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals. It means that it is important to generate value for the customer, society, and the economy it is your starting point.
- Principle 2. Create continuous process flow to bring problems to the surface. Make flow evident throughout your organizational culture.
- Principle 3. Use pull systems to avoid overproduction. It is important to provide a downline customer in the production process with what they want, when they want it, and in the amount they want.
- Principle 4. Level out the workload (heijunka). Eliminating waste is just one-third of the equation for making lean successful. Eliminating overburden to people and equipment and eliminating unevenness in the production schedule are just as important, yet, generally, not understood at companies attempting to implement lean principles.
- Principle 5. Build a culture of stopping to fix problems, to get quality right the first time. Quality for the customer drives the value proposition.
- Principle 6. Standardized tasks are the foundation for continuous improvement and employee empowerment.

- Principle 7. Use visual control so no problems are hidden. It is important to use simple visual indicators to help people determine immediately whether they are in a standard condition or deviating from it.
- Principle 8. Use only reliable, thoroughly tested technology that serves your people and processes.
- Principle 9. Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.
- Principle 10. Develop exceptional people and teams who follow your company´s philosophy.
- Principle 11. Respect your extended network of partners and suppliers by challenging them and helping them improve.
- Principle 12. Go and see for yourself to thoroughly understand the situation (genchi genbutsu).
- Principle 13. Make decisions slowly by consensus, thoroughly considering all options.
- Principle 14. Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen).

These fourteen principles work as guidelines to become a real lean culture. Through the execution of these principles, companies can present results as the form of higher productivity, higher flexibility of the productive system, lower unit costs and superior quality (Black & Steve, 2003).

2.1.2.2. TPS House

TPS is, for Liker (2004), something that surpasses an isolated set of Lean tools, presenting it as a production system in which all parties contribute to a common goal: better quality, reduction of costs, reduction of lead times, better safety and a better state of mind. Figure 16 represents the way that the author identified to represent the principles, values and culture that underpin the Lean philosophy.

Figure 16 - TPS House
Liker (2004)

The objectives of the TPS philosophy are described on the roof. It is based on two fundamental pillars:

- Just in Time (JIT) – the production system where the right quantities are produced at the right time. This system comes with the need to adjust the pace of the processes to the needs of customers, based on Takt-time, ensuring continuous flow (Ohno, 1988).
- Jidoka or "Autonomation" - Jidoka symbolizes the quality at the source making visible the problems for the search for continuous improvement (Shingo, 1989).

In the central area of the house concepts such as the reduction of waste and the involvement of employees always focusing on the search for continuous improvement are visible. Ohno

(1988) also added the concept Kaizen, which in Japanese means change for the better, a philosophy that aims the continuous improvement of all production processes as well as the motivation and integration of employees in the search of beneficial results for the company.

The foundation of the house consists of well-defined, stable and standardized processes, level production (Heijunka) and a high use of Visual Management and knowledge of Toyota philosophy.

2.1.2.3. Lean Thinking

After the success of the best-seller book from Womack, Jones, & Roos (1990), these authors received many requests from companies that want to know how to implement Lean production. To respond to these requests Womack e Jones (1996) published a second book named Lean Thinking, with the principles for companies to follow in order to implement Lean. They started calling the philosophy behind the system: Lean Thinking (Wilson, 1997). Lean Thinking is the antidote to waste. It is a philosophy to achieve more with less (Jalali et al., 2016). This philosophy has five principles which are:

- **Identification of value** – means that value is always defined by the customer's needs for a specific product. Only the ultimate customer can define value. It specifies the important requirements or expectations that must be met (Womack & Jones, 1996);
- **Value stream** – it is the mapping of all activities that identifies all the actions that take a product or service through any process, distinguishing the value-added activities from the non-value added;
- **Flow** – this step is made to be sure the remaining steps flow smoothly with no interruptions, delays, or bottlenecks;
- **Pull** production – it is deeply connected to the production, where the costumers pull the products, preventing the increase of stocks;
- **Pursuit perfection** – it is perhaps the most important, making Lean Thinking and process improvement part of a corporate culture.

2.1.2.4. Waste Types

The reduction of waste is one of the premises of the TPS house. Waste is referred to as any activity that does not add value to the end customer and that he is not willing to pay (Ohno,

1988). There are three types of activities: the ones that create value; activities that do not create value, but are necessary; and activities that do not create value and are unnecessary. The main goal of each process improvement is minimizing the activities that are unnecessary.

According to Hines and Taylor (2007), about the productive area, usually only 5% of activities in companies are activities that add value. In activities that do not add value, 60% do not add any type of value and 35% are necessary. As for administrative resources, activities that add value are only 1%, 49% of activities do not add value, and 51% are worthless but necessary activities.

Shingo (1989) and Ohno (1988) recognize seven different types of wastes:

- **Overproduction**: it represents the production of a certain product without a request from the customer;
- **Waiting**: represents the time that the materials, resources or information are not available when needed, thus losing the efficiency of the productive system;
- **Transport**: any type of movement by materials, operators or useless equipment, since it requires time and does not add value to the product or service;
- **Motion**: unnecessary movement of people and information in the various stages of production;
- **Over-processing or incorrect processing**: this waste is generated by the incorrect execution of processes or by the repetition of operations due to lack of effectiveness;
- **Defects**: also referred to as nonconforming products, defects are considered waste, because in addition to the consumption of resources, time is spent and the tools and equipment are deteriorated;
- **Inventory**: the accumulation of raw materials, processed products and finished products that often come from unbalanced processes, defects, failures in production planning.

Several authors, among them Liker (2004), defend the existence of an eighth waste: the non-use of human talent. Not to take advantage of the skills and creativity of the different employees of the company, thus being wasted opportunities for improvement and growth.

2.1.3 Lean Project Management

Lean project management has many ideas in common with other lean concepts, however, the main principle of lean project management is delivering more value with less waste in a project context (Lloyd, 2013).

Lean project management is the application of Lean manufacturing principles to the practice of the management of projects (Moujib, 2007). Moujib (2007) concludes that the approach of the Lean Project Management needs to perceive the projects as a value stream. Value stream mapping can be an important tool for project management processes improvement. The next step is to recognize the importance that the value of the costumer is the same as the value that the team is working on. The team needs also the culture of eliminating wastes to ensure the project success.

The toolbox of the Figure 17 reconciles the project management process group model based on the PMBOK framework with the Lean principles.

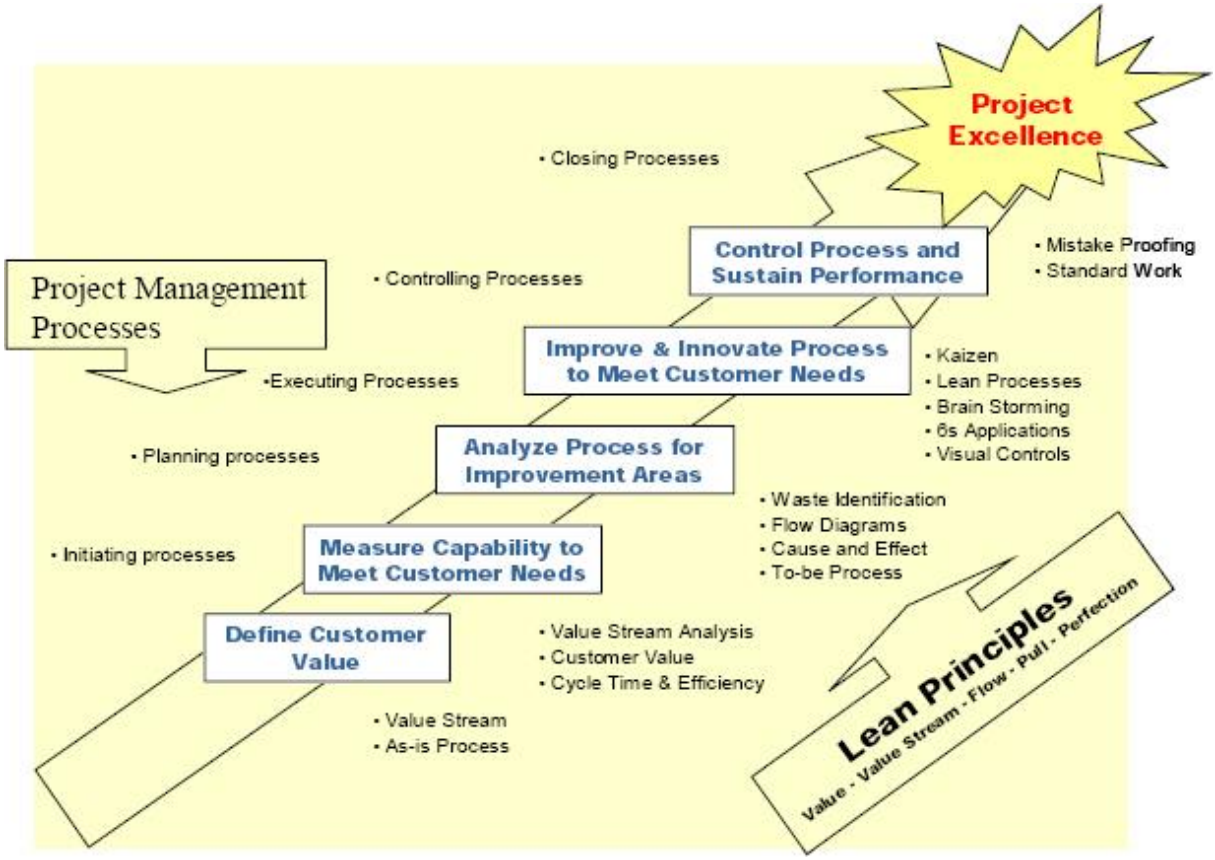

Figure 17 - Project Management Framework and Lean Thinking principles

Adapted from Moujib (2007)

Ballard and Howell (2010) explain the existence of the same toolbox mentioned earlier. It reconciles the project management process group model based on the PMBOK framework with the Lean principles described in this paper.

The important exercises within LPM is the identification of Value added and value-enabling activities. Continuous improvement of project management processes will ensure that you maintain an acceptable level of performance. Adherents of lean project management advance an alternative perspective. Production is defined as designing and making things. Designing and making something for the first time is done through a project, which is, for that reason, arguably the fundamental form of production system. Projects are temporary production systems. When those systems are structured to deliver the product while maximizing value and minimizing waste, they are said to be 'lean' projects. Lean project management differs from traditional project management not only in the goals it pursues, but also in the structure of its phases, the relationship between phases and the participants in each phase (Ballard et al., 2010).

Further ahead on the discussion, the role of the Lean Project Management is not referred a lot of times, because the study aims to outline other methodologies rather than explain the ones that are most known.

2.1.4 Agile Methodologies

During the year of 2001, a wide range of articles was published reflecting a growing interest in new approaches to software development. In order to exchange ideas and discuss new approaches, 17 software developers met, and from that, emerged the Agile Software Development Alliance. Some of the guests were highly attached to the creation of methodologies or frameworks like Scrum (Ken Schwaber; Mike Beedle, 2001), Lean Software Development (Poppendieck, Poppendieck, & Wesley, 2003), Crystal Methodologies (Cockburn, 2004), Feature Driven Development (FDD) (Palmer, S. R., Felsing 2002), Adaptive Software Development (James Highsmith, 2000), Dynamic System Development Method (DSDM) (Stapleton, 1997), and Extreme Programming (XP) (Kent Beck & Fowler, 2000).

By the end of this gathering, the Agile Manifesto (Fowler & Highsmith, 2001a) was created. In the manifesto, the participants underlined four common values (Fowler & Highsmith, 2001b), which are described on the Figure 18.

Figure 18 - Agile Manifesto Values

These values are the basis to the development of the 12 principles for management of projects, described in the Agile Manifesto Fowler and Highsmith (2001):

1. The highest priority is to satisfy the customer through early and continuous delivery of valuable software;
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage;
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale;
4. Business people and developers must work together daily throughout the project;
5. Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done;
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation;
7. Working software is the primary measure of progress;
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely;
9. Continuous attention to technical excellence and good design enhances agility;

10. Simplicity – the art of maximizing the amount of work not done – is essential;
11. The best architectures, requirements, and designs emerge from self-organizing teams;
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

More than ever, they must reduce time to market, without neglecting the delivery of innovative products to achieve customer satisfaction. To conclude, it is important to say that even the most recent volume of PMBOK (Project Management Institute, 2017) has a new section with the Agile Methodologies, which is an important fact due to the relevance and importance of the manual.

2.1.5 Hybrid Methodologies

Hybrid Project Management is a new method that combines the formal and Agile methods. It employs the thoroughness of the Work Breakdown Structure (WBS) with speed and lean benefits of Agile for a new project management method which is both detailed and fast(Binfire, 2019).

The difference of the hybrid project management method to the others is that it lets the team plan before starting to work on the project, but also divides the development cycle into short-term deliveries called sprints.

Hybrid can handle requirement changes and, due to its iterative nature, can deliver products in stages. In hybrid, the planning is done using the waterfall approach. The execution and delivery are handled by the Agile method. This hybrid approach makes the planning and project estimation a lot more accurate. At the same time, the team can react to market changes and deliver what the market demands in place of what the team planned. Hybrid methodologies can have great potential, as these can be seen as a mixture of techniques and methodologies. Therefore, depending on the context, a new framework can be adapted with certain specifications(David R. Robins, 2017). Projects often combine elements of different life cycles in order to achieve certain goals. A combination of predictive, iterative, incremental, and/or agile approaches is a hybrid approach (Project Management Institute, 2017)

The next sub-chapter is going to present a detailed description about what was found on the literature about hybrid methodologies.

2.2 Critical analysis and discussion

In this section, the author answers to the research questions raised, by discussing these to the light of literature reviewed.

2.2.1 What is the relation between Lean Thinking and Project Management?

The word Lean is closely linked to the production environment, playing an important role in each production site, however, this philosophy has evolved into countless fields throughout the decades. Lean originally arose in manufacturing as a way of producing products while minimizing waste in all of its forms (Tripp and Armstrong,2018). On this section will be presented what is written on the literature about the direct engagement of Lean philosophies and project management.

This topic gathered some opinions that Lean, according to Demir et al. (2013), is good at dealing with continuous flows, repeated tasks and low variety and high volume products. This means that on an uncertainty environment, like the project management environment, Lean cannot be easily applied. In its turn, Middleton and Joyce (2012) claim that the application of lean ideas would improve the capability of a software development project and Holweg and Maylor (2018) posit that Lean Thinking can equally be of value in a transient context where the overall system (project) is being designed and redesigned as the project progresses. As it is possible to identify that this is not a consensual question.

The lean approach to Project Management is made to involve everyone in the project, to design quality into the product, to solve root causes of problems rather than their symptoms, eliminate waste, strive for fast delivery, and maintain continuous improvement (Tripp & Armstrong, 2018). Lean software development is an evolutionary, incremental approach as advocated by Gilb and Finzi (1988) as cited in (Middleton & Joyce, 2012).

According to what was found on this research there are not a wide range of articles connecting the project management (the predictive approach) with Lean philosophies. This fact can be explained having in account the specific keyword search that was developed on the methodology strategy.

Although, Demir et al. (2013) proposed a framework which should allow Project Management, Lean and Agile methodologies being merged into one unit. On its way, the main evidence is the creation of Lean Software Development (Poppendieck et al., 2003), referred in section 2.1.3. In the other hand, the evidences of interactions of Agile Methodologies and Lean are in a higher number, which Lean software development is the main methodology within these two fields. The advocates of Lean or Agile argue that current Project Management theory is obsolete in today's dynamic and globalized projects (Koskela, L., & Howell, 2002) as cited in (Demir et al., 2013).

Agile was mainly a reaction against the document heavy, plan driven software development approaches that were frequently not successful. Lean ideas helped provide a context and specific tools for the development of Agile (Middleton & Joyce, 2012), despite the fact that, the Agile Manifesto, which was produced in 2001 contains no references to Lean. As examples of this interaction, it is possible to found that Scrumban which was derived from Kanban. The scrum itself is similar to Toyota's small work groups with their daily stand-up meetings (Middleton & Joyce, 2012).

There are some frameworks that can interconnect these two topics in the literature, for example, the Leagile approach as suggested by Naylor, Naim, and Berry (1999) as cited in Demir et al. (2013). Leagile also combines Agile and Lean through, using the decoupling point model, where a switch from one paradigm into the other takes place sequentially (Naylor et al., 1999)(Naylor et al., 1999;Taylor, Mason-jones, Naylor, and Denis, 2010; Goldshy & Griftis, 2006). There are also the AgiLean PM (Demir et al., 2013) that eliminates waste in the processes allowing these to react to change. There are other frameworks indirectly attached to Lean, namely the Lean Six Sigma approaches.

It is impossible to mention the connection of Lean Thinking and Project Management without mention Lean Project Management (Moujib, 2007). The methodology has obvious origin on the application of Lean Thinking principles to the management of projects. The major objective is on improving processes and reducing waste. Also, Lean management helps to improve efficiency and effectiveness of a project team. Lean project management aims at eliminating waste of time and resources as one of the aspects of overall improvement (Stepanov, 2018). A Project Management Institute conference paper by Aziz Moujib (2007) describes Lean project management as the application of Lean manufacturing principles to

the project management process. This is to achieve the same goal: maximizing value while minimizing waste. In section 2.1.3 is explained the Lean Project Management toolbox that Moujib (2007) described.

Like it was possible to thought on the first times of this philosophy, Lean production works in controlled situations and processes that repeat over the time. Well, a project does not fit in this model of repetitiveness, it is all about uncertainty most of the times. However, all the philosophy that is on the base of the Lean can be applied to the management of projects, since it is possible to apply Lean Thinking principles in every context.

To conclude, it is possible to understand that, even though Lean production is a field with credits signed in the literature, alignment with Project Management can be controversial for and generate distinct opinions among the researchers.

2.2.2 What project management methodologies were found on this research?

The main goal of this section is to give an overview about what was found on the literature (within the scope of the SLR) about project management methodologies. From an end user view, this research will enumerate a list of methodologies and practices as well as different perspectives and visions of the field.

The scholars of the area of project management enunciated over the years a kind of agility spectrum for project management methodologies, where it is possible to identify two different areas on the end of each side of it. The plan-driven methodologies/traditional/heavy weight, from one side and the Features-driven methodologies/agile in the other. Above, the definitions about these are presented, just like some examples of the different methodologies and practices of each. Nonetheless, it is important to point out a relatively recent wave that can consider itself as standing somewhere between the two types of methodologies in the spectrum, the called Hybrid methods, which are mainly methods that have characteristics of both the types.

There is a recent consensus among scholars that agility is a way of coping with external and internal changes, which are viewed as unpredictable and uncertain (Dyck and Majchrzak 2012). Many studies have shown that a majority of the projects exceed their initial costs and deadlines or even remain incomplete. The question is: Why a majority of the projects fail? There is no a common answer. What is certain is that the causes of project failure are many.

Of course, to avoid the failure of a project it is desirable that project plans are aimed at being flexible and to allow changes even late in the process (Petrillo, Di Bona, Forcina, & Silvestri, 2018).

Some authors as Utterback, Meyer, Tuff, and Richardson (2016) defend that traditional project management approaches can be counter-productive. According to Wysocki's (2009) cited in (Dyck and Majchrzak 2012) testimonial data gathered from 10,000 project managers, no more than 20 per cent of all projects have the characteristics of traditional projects, but research shows project managers continue to apply these traditional methods to projects for which they are not suited.

Despite this vision, traditional Project management cannot be taken apart, being an important guide to a wide range of industries. According to Ahimbisibwe, Cavana, and Daellenbach (2015) Traditional plan-based approaches encompass PRINCE2 (Office of Government Commerce 2009) and PMI (PMBOK, 2013). Other authors like Rehacek (2017) adds ISO 21500 and IPMA ICB as global standards, each one, with a set of contract-driven methodologies that seek adherence to a pre-established plan, as well as presumed certainty, stability, and ease of targeting/controlling existing processes (Dyck and Majchrzak 2012).

In addition to what was said before, and as one of the conclusions of this research it is possible to point out that, in some cases, big companies opt to develop their own project management methodologies. These methodologies are, most of the times, based on the methodologies presented before, however, they appeared on the scope of this research. The most important frameworks that were found were the RUP (Rational Unified Process) deployment project published by the Rational Software Cooperation (acquired by the IBM later) (Hewagamage & Hewagamage, 2011) the MSF (Microsoft Solution Framework), the Project Methodology (ITPM), Personal Software Process (PSP), Team Software Process (TSP), and LFA.

It is now time to look at the examples of methodologies that were found on this research, regarding to agile approaches. Like was said before, the name agile born from a reunion of project managers, each one of them with their own methodology. They were: Scrum (Ken Schwaber; Mike Beedle, 2001), Lean Software Development (Poppendieck et al., 2003), Crystal Methodologies (Cockburn, 2004), Feature Driven Development (FDD) (Palmer, S. and Felsing 2002), Adaptive Software Development (James Highsmith, 2000), Dynamic System

Development Method (DSDM) (Stapleton, 1997), and Extreme Programming (XP) (Kent Beck and Fowler, 2000).

The advantages of agile project management and particularly the Scrum-based approach is its simplicity (Cervone, 2014). Scrum is a method of agile development and it is an iterative, incremental framework for development. It puts emphasis on the cross-functional teams working in short development bursts called “Sprints” to regularly produce a complete increment of a product (Anwar, Hafeez, Asghar, Shabbir Hassan, & Hamid, 2014). Extreme Programming is a software development methodology which does not rely on any particular tool, but rather is based on the common understanding of fundamental values and on a disciplined application of best practices (Angioni et al., 2006). The central idea of planning in XP is to plan features to implement rather than the development tasks necessary to implement these features (Van Valkenhoef, Tervonen, De Brock, & Postmus, 2011). These methodologies are highly used nowadays, mainly in software development projects, and are frameworks adapted by contexts with a high degree of agility.

Other methodologies and frameworks have been created throughout the times, with more or less agility, normally adapted to the context and needs of the users. The examples that were found were the Kanban, Dev Ops, Scrumban, Leagile (Demir et al., 2013), Agile UP, Safe, Less, DAD, CMMI, IVPM2 Iterative and Visual Project Management Method and TOC/CCPM (Goldrat, 1997). CCPM is an emerging scheduling method that relies on buffers for protecting schedules from overruns and requires resource leveling to develop feasible and competitive schedules (Gu, Li, Ma, Ai, & Wang, 2014). Critical Chain Project Management (CCPM) was developed on the foundations of TOC (Theory of constrains) (Trojanowska & Dostatni, 2017). Beyond this list, it were also found other methodologies, which were referred, but there is not sufficient information to understand their agility like CH2MHill, Nasa Systems, Rapid application development, ITIL and Iconix.

The newest member of the equation is this hybrid field however, it seems that it is still a little confusing for the managers. The project management research community should further investigate how to develop “hybrid” management models, considering Agile Project Methodologies and traditional approaches, in order to balance the “agility” (Conforto et al., 2014). F. Tripp and Armstrong (2018), refer that some studies have looked at the integration of these “hybrid” approaches, such as product line engineering, plan-based requirements

prioritization, documentation driven methodologies, lean methodologies, service-oriented methodologies and most recently capability maturity, but without the effectiveness that is expected. The words Wagile and Agifall are other ones that are new to project management vocabulary, and they signify whether the approach leans more towards waterfall or agile. Agifall introduces more robust stages of research, strategy and planning phases into tasks and proceeds with sprints to complete them. So, it's basically an agile project with more information up front. Interestingly, the term Wagile has a negative connotation. It implies that some agile practices have been adopted but the project has been slipping back into waterfall. Such badly managed agile can transform eight 2-week sprints into a series of eight-time boxed waterfalls. Basically, wagile is thought of as waterfall masquerading as agile through daily standups and short iterations, but without principally stepping away from the traditional model.

For now, it may be difficult to find a simple explanation for these approaches, however, the author suggest that the use of a hybrid framework can be built after an intensive study of the needs and characteristics of the environment in question.

To conclude it is possible to say plan first, execute second because this is the paradigm of traditional project management. Adapt to change as you iterate - this is the paradigm of agile project management. These competing methodologies represent two ends of a spectrum between linear (traditional) and non-linear (agile) project management processes (Baird & Riggins, 2012).

More important than the name of the methodology, it is important to understand the context before the implementation of a new way of managing the projects. If it is right to say that there is no need to invent the wheel, it is also true that each case is different, hence, it is required a diagnostic study with diagnostic tools (Agile suitability assessment charts, semi-structured interviews and so on) to implement a new framework, and this is the main conclusion that is possible to take from this research. Since the context is identified, this research brings the user a rich database for the existing methodologies.

3. COMPANY PRESENTATION

This chapter is dedicated to the description of the company where the master thesis project was made. Firstly, some characteristics about the Bosch Group and its business areas will be described. Then an overview about the situation of the company in Portugal, specifically in Braga, will be presented.

3.1 Bosch group

In 1886, Robert Bosch (1861-1942), in Stuttgart Germany, opened his own "Workshop for Precision Mechanics and Electrical Engineering", and years later, was the first one to adapt a magneto ignition device to a vehicle engine. That figure originated the actual logotype associated to the company. Right from the start, the company, was characterized by innovative strength and social commitment.

The company, named as Robert Bosch GmbH, started to grow in an accentuated rate, and by the year of 1906, Bosch had subsidiaries in London, Paris and New York. Nowadays, Bosch is a world leading multinational engineering and Electronics Company headquartered in Gerlingen, near Stuttgart, Germany. It is responsible for 440 subsidiaries, installed in 60 countries, employing approximately 402 000 associates. The company generated sales of 77.9 billion euros in 2018 distributed by all its business sectors (Bosch, 2019c).

The Bosch Group's strategic objective is to create solutions for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life".

3.2 Business areas and divisions

Bosch group divides its operations into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Mobility Solutions business sector is responsible for nearly 60 percent of total Bosch Group sales. The areas of activity of this business sector are, among others, injection technology and powertrain peripherals for internal-combustion engines, solutions for powertrain electrification, steering systems, safety and driver-assistance systems, technology for user-friendly infotainment as well as vehicle-to-vehicle and vehicle-to-infrastructure communication, repair-shop concepts,

and technology and services for the automotive aftermarket. This project will be developed, specifically in a subsidiary of the Car Multimedia (CM) area.

The Industrial Technology business sector generated roughly 10 percent of total Bosch Group sales. This area includes customized drive, control, and linear motion solutions for factory automation, plant construction and engineering, and mobile machinery.

The Consumer Goods business sector contributed with 23 percent of total Bosch Group sales in 2018. Its Power Tools division is a supplier of power tools, power-tool accessories, and measuring technology.

In 2018, the Energy and Building Technology business sector generated roughly 7 percent of total Bosch Group sales. It has two areas of business: the global product business for innovative security and communications solutions, and the regional integrator business (Bosch, 2019b).

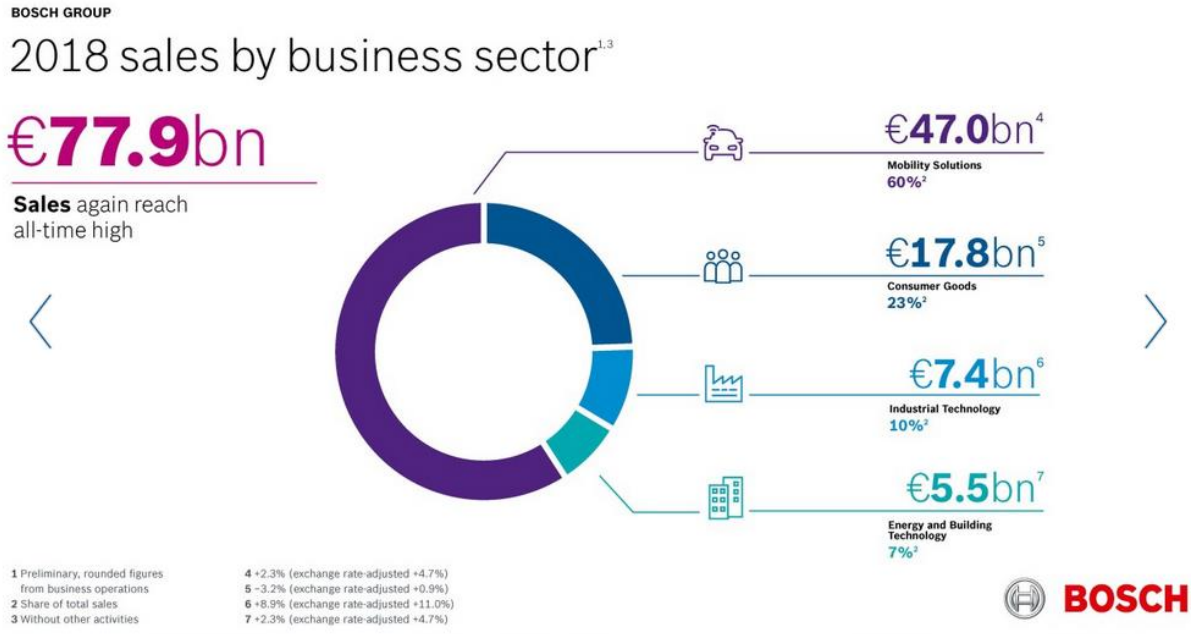

Figure 19 - Bosch sales 2018
(Bosch, 2019b)

As a leading IoT (Internet of things) company, Bosch offers innovative solutions for smart homes, smart cities, connected mobility, and connected manufacturing.

3.3 Bosch Car Multimedia

The Car Multimedia (CM) division provides smart solutions for the versatile and highly effective integration of entertainment, navigation, telematics, and driver assistance functions

in the vehicle. It also supplies infotainment, display, connectivity and HMI solutions for passenger cars, trucks, two-wheelers, and off-highway vehicles.

With approximately 6200 employees spread around the world, the division's expenditure on research and development will during this year, alone, amount to approximately 240 million euros (Bosch, 2019d).

3.4 Bosch in Portugal

As it was said earlier, Bosch is a multinational company present in several countries around the world. Portugal, which is the country where this project was developed, is no exception. It had 5548 associates at the year of 2017, distributed for four different locations spread through the country. These are the Bosch Termotecnologia, S.A., located in Aveiro, Bosch Car Multimedia Portugal, S.A., located in Braga, the Bosch Security Systems - Sistemas de Segurança, S.A. and the Robert Bosch, S.A., located in Lisbon (Bosch, 2019a).

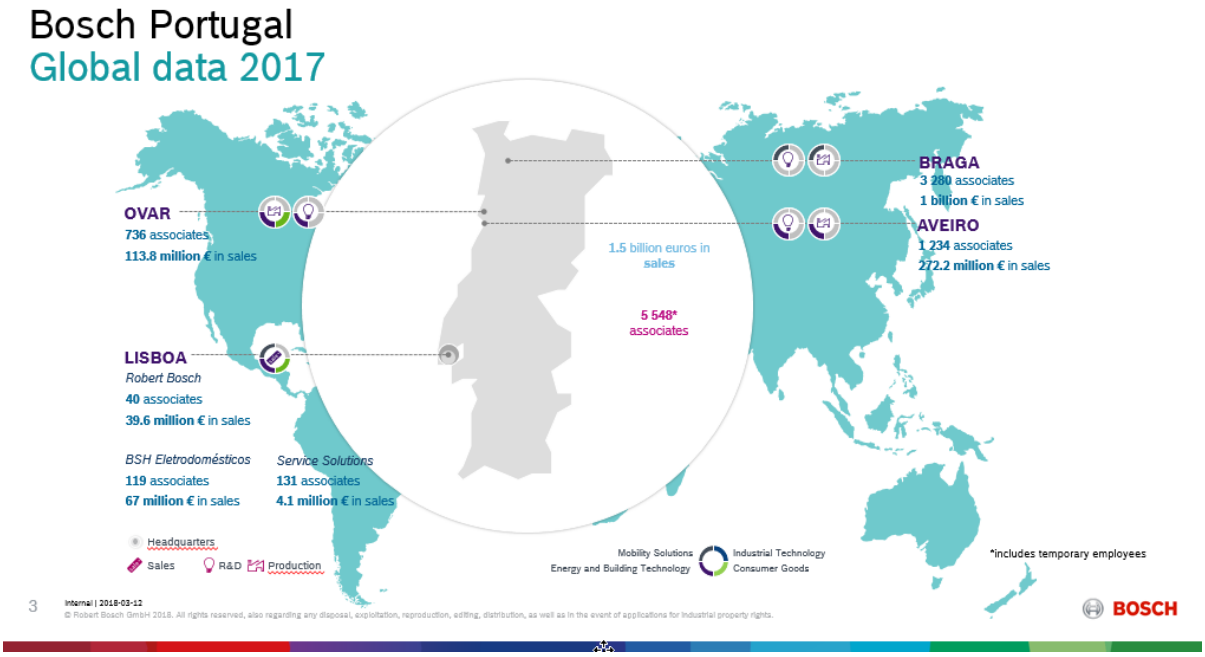

Figure 20 - Bosch Portugal
(Bosch, 2019a)

3.5 Bosch divisions Braga

Bosch Braga (BrgP) was founded in 1990 under the name Blaupunkt Auto-Radio Portugal Lda. and produced car radios for the Blaupunkt brand. In 2008, the Car Multimedia division (CM) was restructured and the Blaupunkt brand was sold along with the aftermarket radio business

segment. Since then, CM focused only on original equipment for the car industry and the plant was renamed Bosch Car Multimedia Portugal, S.A.

Bosch (BrgP) is divided in several departments. This type of organizational structure is important because it allows a bigger control and organization on the areas of the company.

In a high level, the company divides itself in two different areas: the commercial and the technical area. Both areas have a different responsible, who is in charge of managing its areas, and report directly to the host company in Hildesheim, Germany.

Relatively to this project, it was integrated in the logistics department (LOG), more specifically in the Logistics Innovation section (LOI). The LOG department is divided in several sections as:

- LOP - Responsible for the shipment of final product, consequently, makes it responsible for the management of customer orders and consequent production planning;
- LOM - Responsible for internal logistics management, or in other words, the management of raw material warehouse and supply of production lines;
- LOS - Responsible for the purchase of raw materials and the management of their reception at the Bosch BrgP site;
- LOT - Responsible for the management of transport by lorry, sea and emergency (airplane), as well as for transport support that requires customs services;
- LOD - Responsible for the management and development of packaging;
- LOI - Responsible for the realization, control and management of innovation logistic projects aimed at improving the performance of the LOG department. This section also has the responsibility of supporting the remaining LOG department regarding the use of the company's ERP system;
- LOC - Responsible for controlling the performance of the entire LOG department, about its associated costs;
- LOQ - Responsible for quality control of logistics processes. It is here where Bosch customer complaints are handled and processed (Bosch, 2019a).

4. Description and Critical Analysis of CM/LOI Current Situation

In this chapter it will be succinctly described the way of working of the department of CM/LOI – BrgP, and its characteristics. A critical analysis was performed to the current situation, using some tools such as semi-structured interviews, suitability assessment charts, Ishikawa diagrams, Pareto charts and other Lean tools. To conclude, not only a synthesis analysis of the problems identified was done, but also the degree of agility of the department was determined, to finalize this characterization. Doing the bridge between what was clarified at the introduction, this chapter presents the diagnosing phase of the action research cycle,

Figure 21 - Diagnosing phase

where the aim was to define the context and the problems of the context (Figure 21).

4.1 Logistics Department operation

As previously stated, this research took place at the CM/LOI-BrgP department, which has several functions and roles on the logistics of each Car Multimedia headquarter. Placed in Braga, it is responsible for the realization, control and management of logistics oriented innovative projects, which are attached to the development of the company in order to obtain even more accomplishments. Most of the projects that are currently in execution are Industry 4.0 (I4.0) projects with new technologies and innovative developments. These i4.0 projects are made on the development of very different technologies in order to continue the technological development of the company, as it is possible to see in Costa, Carvalho, Fernandes, Alves, and Silva (2017) or Freitas (2017).

Furthermore, this section has also the responsibility of supporting the remaining LOG department, regarding the use of the company's ERP system. Independently of these

important roles, the department lives mostly due to a significant number of ongoing projects, which are from different types and for different purposes.

Bosch Car Multimedia is an important partner on the development of the technology on the region, and the department at which this project was built has an important role on that development. Nevertheless, there is always space for improvements, and a project base department needs to follow a well-defined strategy, in order to be competent and competitive. Strategically speaking, projects have three different origins:

- **Costumer requisitions** – They are a type of projects specifically designed to attend customer requirements and needs. Usually they are not capable of satisfying other clients' needs;
- **Continuous improvement** – Projects which main goal is the reduction of costs and improvement of processes;
- **Strategical projects** – Innovation projects to improve the general status of the company. They are projects that preserve the sustainability of the organization, and usually are on a more strategic level.

The scenario that was found at the department is described on the Figure 22.

Figure 22 - Project Business Strategy I
(Bosch, 2019d)

The strategy consists on giving priorities to projects that are meant to fulfill costumers' needs, for a quick answer to specific requirements. Then there are projects for the improvement of the previous projects, and, the last ones are the strategical projects.

Regarding to project management methodologies there is a framework that was created eight years ago for the department, however, at this time, it is not used in current projects. Despite the existance of this framework, there is another methodology, created by the BOSCH Group for the management of projects, which is not used too.

4.2 Diagnosis and main problems

Once the departments operation is explained, it is time to present the strategy of operations and actions during the diagnosing phase. It is never too much to remember that the main output of this phase is a list of problems that were found on the framework of project management previously used. This framework is presented in the next sections.

The procedure consists in three different steps, which are the past framework analysis, the interviews phase and, finally, the suitability assessment chart (Figure 23). The set of tools used in each phase are also described in that figure, being that it is possible to highlight tools as semi-structured interviews, Ishikawa diagrams and suitability assessment charts.

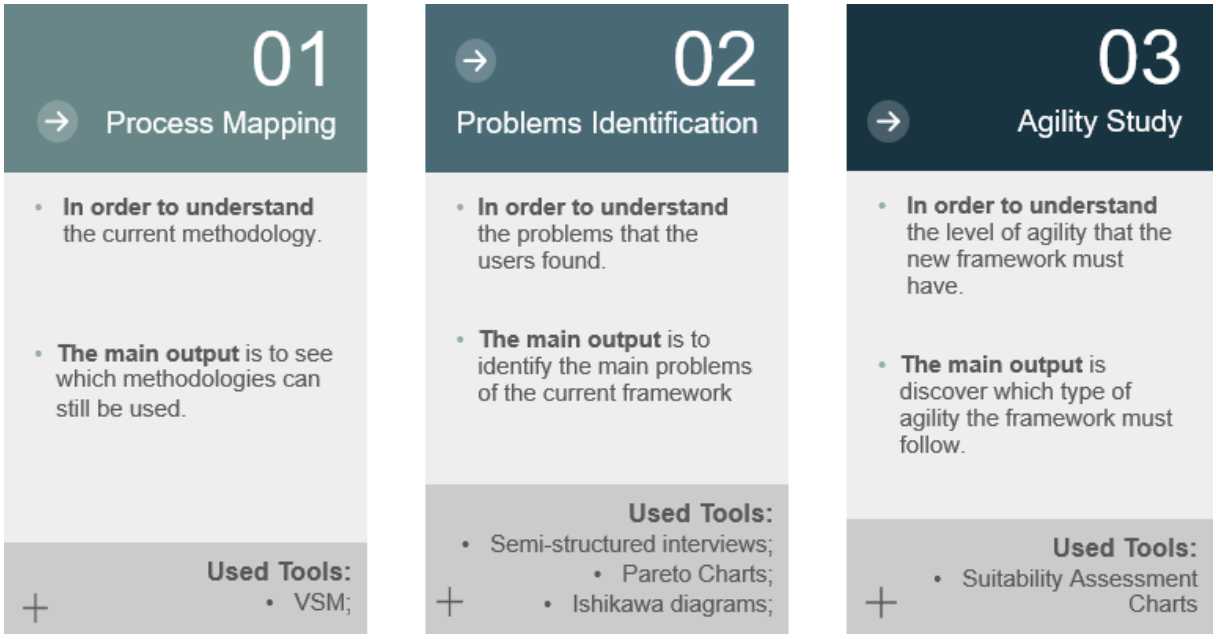

Figure 23 - Diagnosing phase strategy

Once this phase is finished, its output (old methodologies, problems to handle and the degree of agility that it must cover) is going to serve as guideline to the proposal to solve the problems and reach the research goals.

It is important to point out that the process groups are going to be called phases further ahead, since that was the name that was used in the company.

4.3 Process mapping

In order to understand the main practices of project management at the department, an analysis of the framework was done. This process was mapped going through every step of a project lifecycle and schematizing all the tools and major practices in each one of them. The

first phase of this process was to build the framework steps using a diagram, which is attached at Appendix 2.

The framework includes six different phases and five different milestones, approximately with twenty three possible steps and processes and it has around thirteen templates, distributed within the phases to support the framework (Figure 24 and Figure 26).

Figure 24 - Numbers of the framework

From a user point of view, the framework was organized as it is shown in Figure 25.

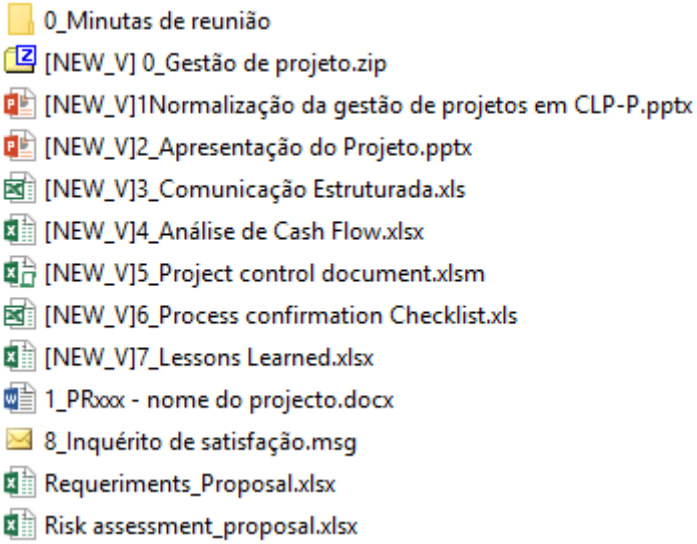

Figure 25 - Framework organization

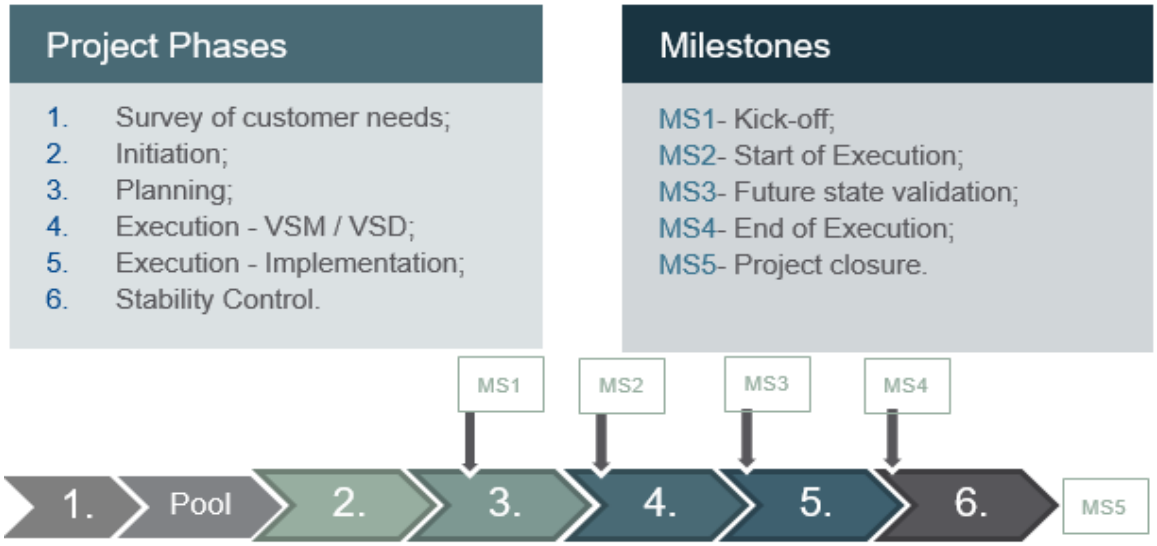

Figure 26 - Old framework summary

4.4 Problems identification

This is an extremely important phase of the research project, which objective is to outline the main requirements that the new framework must cover, based on the resolution of problems found and on the experience of project leaders of the department.

4.4.1 Procedure for problems identification

For this section, a procedure was developed to achieve the main goal which is a list of problems. First, it is important to make some considerations in order to be easy for the reader to understand the process used:

1. There are two different types of problems in this context. The framework problems, which are the ones that are directly attached to the old framework, and the problems related to the management of projects at the department;
2. These two types are linked, and this bond is explained next, therefore a possible solution can solve problems on one side that consequently will solve other related problems on the other side.

These two types of problems seemed to be the same at the first sight, however they are not. Starting to look at the old framework and analyzing it, it was possible to identify some characteristics or problems that, through the use during the times, led to a gradual disuse of that framework. Hence, with the job rotation within the department and the years passing, the framework was practically forgotten. As a result, other problems of project management were born due to this misguided approach. This is the link between the two types of projects (Figure 27), which is going to be presented next.

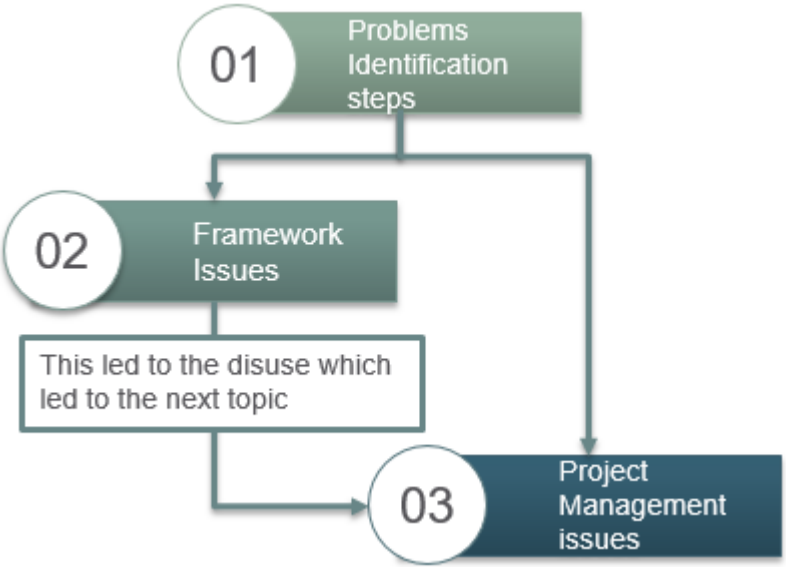

Figure 27 - Problems Identification Steps

4.4.2 Framework problems

This section is responsible to point out the problems that were identified on the old framework, which was characterized in section 4.3.

The procedure consisted on an analysis of each document of the framework separately, simulating examples of projects on them. This way it was possible to understand some characteristics that reveled to be problematic. Table 3 presents a list of the framework problems.

Table 3 - Framework Problems

	Type	Description
1	Missing	The framework does not have any document for Stakeholders Management
2	Missing	Capability Management is not done
3	Missing	Interconnection of information between parts and tools is not done
4	Project Request	Fields with limited space for a complete definition of the project scope

5	Communication Document	It may not be followed, once it is only an excel document, that is not on the internet and it is not interactive
6	Time Schedule	Unintuitive and confusing document
7	Time Schedule	Document with limited flexibility
8	Time Schedule	Document not easy to create
9	Cockpit chart	Document that is not adapted to the reality and the specific characteristics of the multiple projects
10	Cockpit chart	Lack of definition of the KPI's that are associated to the cockpit chart
11	Cockpit chart	Graphically unattractive
12	Open Point List	Lack of explanation on the fields to fill
13	Open Point List	Document that is not interactive, which is an important functionality on the management of work within a project team
14	Open Point List	Graphically unattractive
15	Risk Management	Lack of training for the users
16	Risk Management	Too much information that would be passed through other ways

It is never too much to reinforce that these problems of the framework made impossible for the users to use this framework, and, consequently, other problems related to the management of projects emerged - section 4.4.3.

4.4.3 Project management problems

The problems that were found at the department related to project management are a result of the lack of use of the previous framework. Although this one has its problems, the lack of use ended, in time, by bringing up other more serious problems.

Making a proposal for a framework to manage projects for an entire department, without even consider the requirements and the team feedback about the previous framework, would be a mistake. For that reason, a round of semi-structured interviews with different project leaders with substantial experience on the LOI projects was made.

In this phase, a total of 12 semi-structured interviews were conducted, with 12 different project leaders or team members. The interviews were recorded, transcribed, and analyzed and were used several techniques to increase the study's validity. An interview template was created to serve as a guide to conduct and to ensure the achievement of the objectives, which were previously determined.

It was divided in three parts, where the first one had questions related to basic information on the projects handled by the project leaders, the second one had its scope on the main problems and difficulties that were faced during the years, and the last one was a space to additional comments that might be relevant. It is extremely important to point out that these are the problems found at the department, and not the problems of the framework, since it is not used. The template is attached at appendix 3.

The output of these 12 different interviews is presented in Table 4 where, besides the problems that were identified, and, consequently, the needs that are extrapolated from the problems, it also includes the number of times that these problems were mentioned. This fact can differentiate the importance and the urgency among them. Beyond that the type of waste (Section 2.1.2.4) that each problem brings is also identified.

Since the interviews phase ended, the next step was to draw the main conclusions of the process.

Table 4 - Identification of problems

	Problems	**Number of times that the problems were mentioned**	**Lifecycle phases**	**Types of wastes generated**
1	Folders disorganization	4	Controlling	Defects/Rework
2	Difficulty in time schedule planning	2	Planning	Defects/Rework, waiting and skills wastes
3	Lack of alignment by the stakeholders	5	Initiation	Defects/Rework and waiting wastes
4	Lack of risk management	4	Planning	Defects/Rework and waiting wastes
5	Bad definition and deficit exposure of project requirements	6	Initiation	Defects/Rework, skills wastes
6	Lack of information about the actual state of the project	8	Controlling	Defects/Rework, Overproduction and skills wastes
7	Lack of documentation and important information about the project closure	3	Closure	Skills wastes
8	Lack of definition of roles and responsibilities	7	Initiation	Defects/Rework, waiting and skills wastes
9	Poor management of resources	3	Planning	Defects/Rework, waiting and over production wastes

10	Inexistence of a communication plan	1	Planning	Waiting wastes
11	Poor or inexistence of a deployment phase	2	Initiation	Defects/Rework, inventory and skills wastes
12	Inexistence of a financial analysis;	1	Planning	Defects/Rework wastes

It is important to mention that each phase is not static, and these problems are noticed trough some different phases, however on the table 4 is an organization of the phase where the problem starts. The graph of Figure 28 represents the number of times that the problems were mentioned during the interviews and the related project phase, to allow a better understanding about the process output. It is possible to conclude that the nature of the problems is spread over different project management processes, where the project initiation are the ones where most problems were identified.

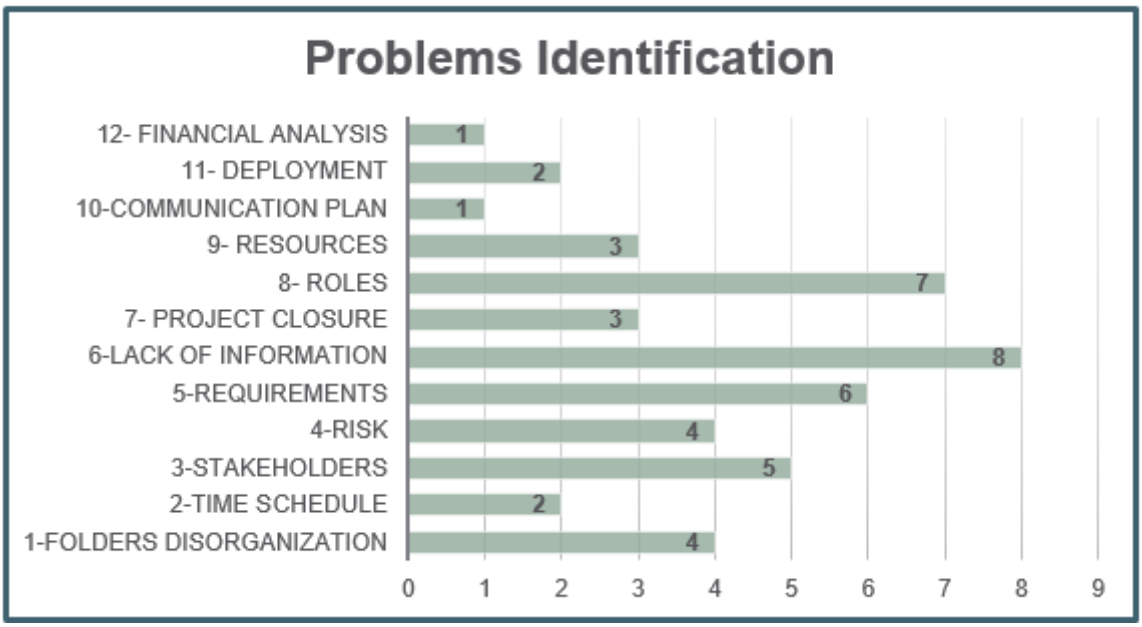

Figure 28 - Graph of the identified problems

It is possible to point out that the 80/20 rule can be partially identified. The 80/20 rule is partially utilized and is possible to see that 75% of the problems identified (nine out of twelve) are on the first two phases of the methodology (Initiation and Planning phases). It can be said that 75% of the identified problems are on the first 40% of the identified phases.

Figure 29 represents a scheme that was based on the Ishikawa diagram, in order to determine the main causes for the occurrence of some problems. The problem of the Lack of alignment by the stakeholders was the problem that was chosen to represent this technique.

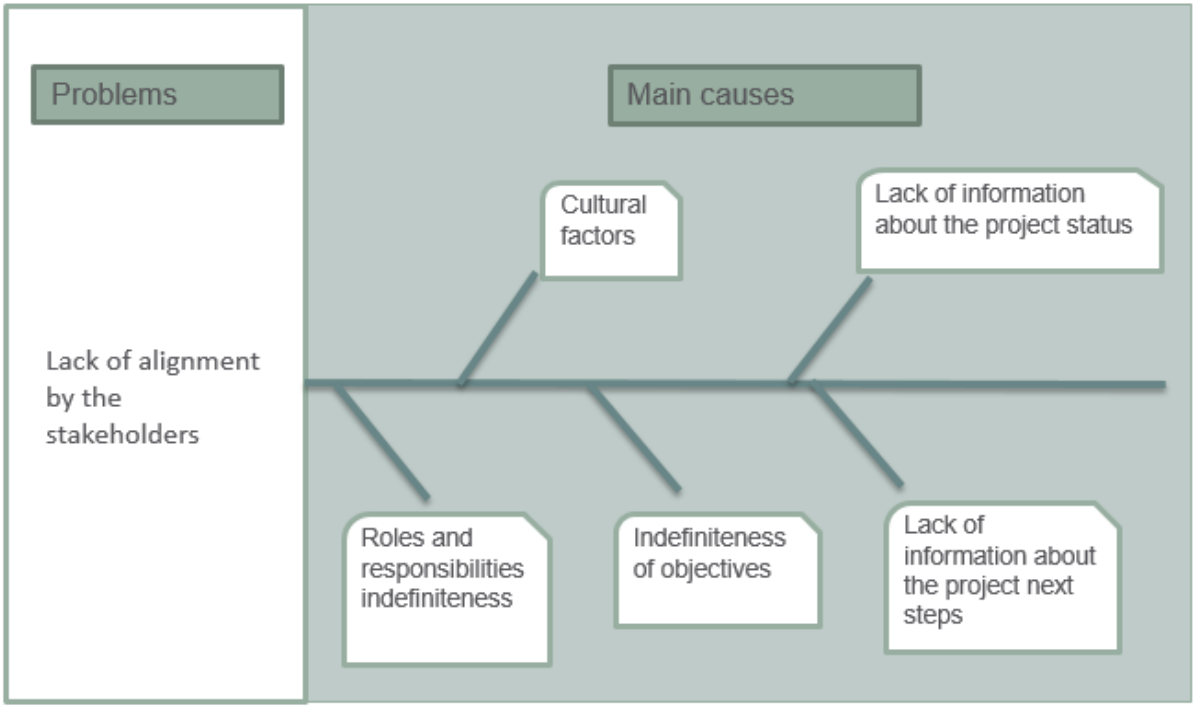

Figure 29 - Ishikawa diagram with the causes of the lack of alignment of the stakeholders

In a nutshell, it is possible to identify that the major problems and needs found on the way that the projects are managed, at this department, can be identified on a macro, meso and micro vision, detailed in Figure 30.

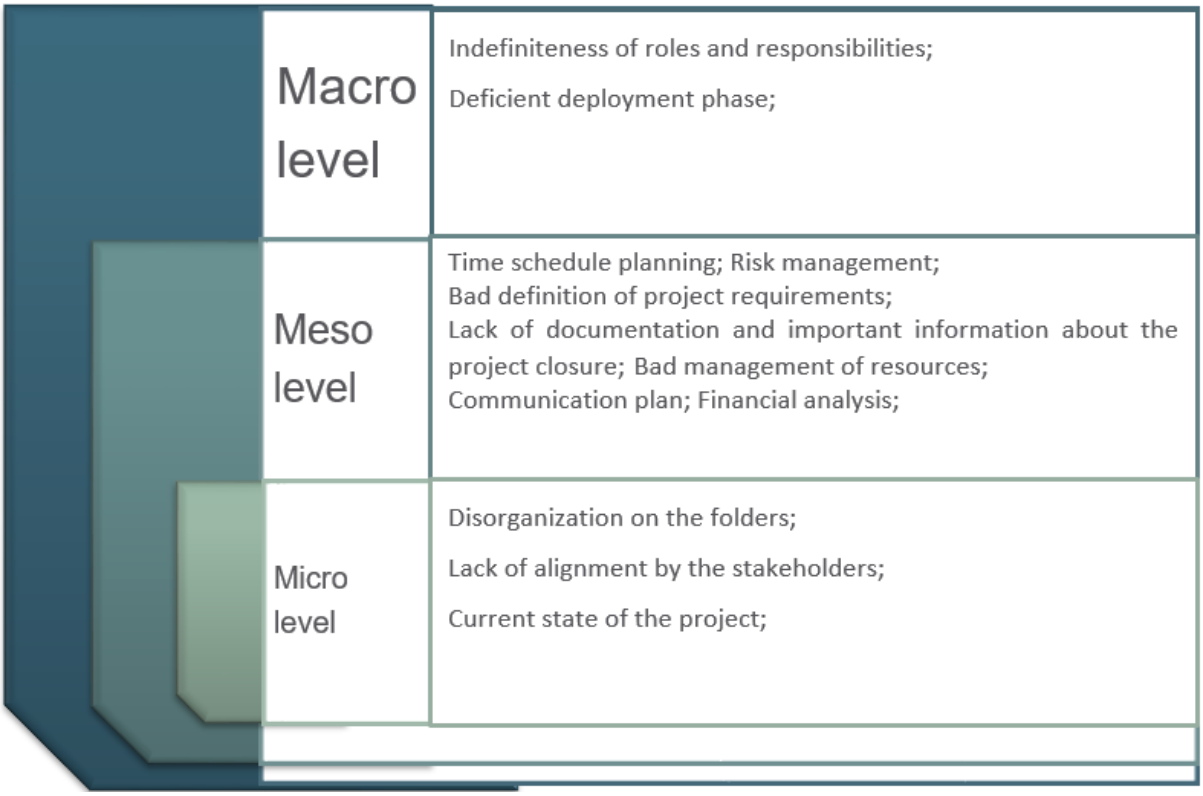

Figure 30 - *Levels of problems*

To conclude it is possible to say that, at this point, sixteen framework problems (section 4.4.2) and twelve project management problems (section 4.4.3) were identified, being that some of them are the same at both lists. These outputs were needed to continue this diagnostic phase.

4.5 Agility Assessment

This section is going to present the suitability assessment chart study, which was developed in order to obtain a better approach to the proposal.

This was the last step of the diagnosing phase, in which the characteristics of the old framework and the identified problems until this point were collected. The missing piece and the main goal of this section is to determine the degree of agility that the new framework must present. The main advantages of this study is a better perception of the needs of the context, which is a really important step on the development of a new framework, as stated earlier.

4.5.1 Suitability assessment chart - Strategy

Firstly, it is important to refer that this study was inspired by the Agile Suitability Filter tool (Project Management Institute, 2017). The thought behind this study is simple. The first step was the construction of an excel quiz template, then, it was sent to different members of the department, and finally, the respective conclusions were achieved, based on the answers. However, it is important to clarify the division of the projects into two types. According to the information gathered on the semi-structured interviews, it was possible to conclude that the department projects can be software development (Group A) and Implementation projects (Group B) (Figure 31).

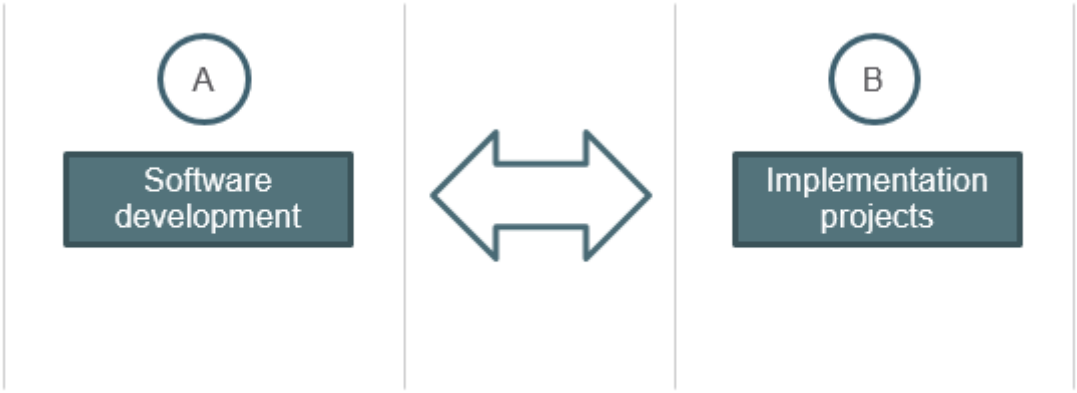

Figure 31 - First division into project types

Further ahead, on the fifth chapter, a new way of characterizing projects was proposed in order to organize the topics of the new framework, however, and at this phase, this represents how the division works.

4.5.2 Suitability assessment chart - Creation

The first field of the quiz is the project identification, where the user is able to insert the project name and type. This section will allow an easier evaluation of the results, since the projects are already divided by types.

The assessment quiz can be divided in three different groups of questions, each group with three different questions, where the first one is the organizational culture quiz, the second is the team members' quiz and the last one is regarded to project issues.

Then, each question has a row of ten possible answers (a scale from 1 to 10), and this is the way that the respondents can classify the respective project by a score in each one of the nine different questions. Twelve different studies were made about old and on-going projects of

the department. The scale that was referred above, starts on the value 1 which is the lowest mark, and it increases until the classification of 10, which is the highest mark.

The excel that was developed gives an automatic answer for each type of methodology and should be adopted for each group of questions, depending on the scoring that was attributed previously. An example of this can be seen in Figure 32. In the figure it is possible to identify the average, the standard deviation, and the median of each point. The average value is the average of every answer of every point in question, for example, for the question 3b, the value 7.67 is the medium value of all the studies that were taken for that specific question. The same logic is made to the standard deviation and the median. The standard deviation can give another input to this study, this because the lower the value is, the better it is considered the study, and for the same group of projects it means that the way of dividing the projects was the appropriate.

	Low				Average		High						
Project	1	2	3	4	5	6	7	8	9	10	Average	Standard deviation	Median
3a. Change of requirements (variation of requirements during design)								x			5,89	1,83	5
3b. How critical is the project? (What impact if there are faults or defects)								x			7,67	1,56	7,5
3c. Frequency of deliveries (number of versions delivered to the final version)									x		5,00	1,72	6

Figure 32 - Quiz example

In order to understand the scorecard of either the quiz or the output graphic, it is important to give some considerations about what is considered, in this case, traditional, hybrid or agile methodologies:

- When the word "**traditional**" is a result, it means that the characteristics found about that specific topic resembles to the ones usually found on plan-driven projects.
- When the word "**agile**" is a result, it means that the characteristics found about that specific topic resembles to the ones usually found on feature-driven projects.
- In its turn, the term "**hybrid**", like was said earlier, represents the characteristics that cannot fit in the other two types. In other words, these characteristics are not too extreme to be considered as "traditional" or "agile".

In the example presented at Figure 33, it is possible to see the score and the respective answer about the agility of the methodology that should be used for the field "project issues".

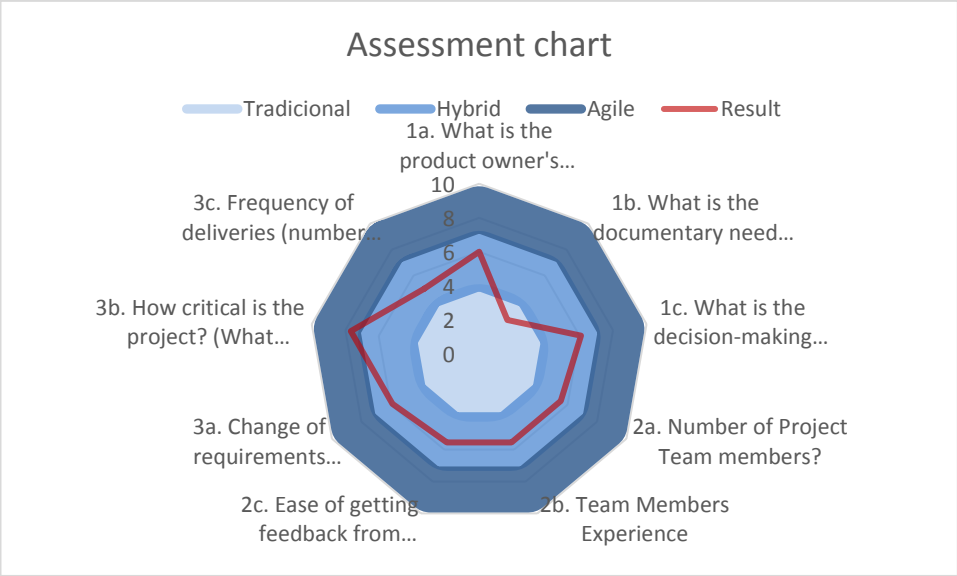

Figure 33 - Graph result – implementation project

4.5.3 Suitability assessment chart - Results

The results were compiled in two different categories according to the two different types of projects, the **group A**, which are the software development results, and the **group B**, which are the implementation results.

In order to understand if the data can be trustable, for each question, it was made a statistical study with the calculation of mean, median and standard deviation Figure 34.

Organizational culture	Average	Standard deviation	Median
1a. What is the product owner's openness to an Agile project management approach?	6,00	1,35	5,5
1b. What is the documentary need of the company?	2,58	0,90	2,5
1c. What is the decision-making power and autonomy of the team?	6,08	1,73	6

Team	Average	Standard deviation	Median
2a. Number of Project Team members?	5,56	1,44	6
2b. Team Members Experience	5,56	1,72	5
2c. Ease of getting feedback from stakeholders	5,56	1,56	5

Project	Average	Standard deviation	Median
3a. Change of requirements (variation of requirements during design)	5,89	1,83	5
3b. How critical is the project? (What impact if there are faults or defects)	7,67	1,56	7,5
3c. Frequency of deliveries (number of versions delivered to the final version)	5,00	1,72	6

Figure 34 - Quiz example

4.5.4 Group A - Software development results and conclusions

For the organizational culture field (the questions 1a., 1b., 1c.), the main fact that can be pointed out is the need of documentation at the department (1b.), which is on the traditional level (the less darker blue field). The heavy documental need is on a traditional level, and this is an important point to take in consideration. Besides that, the other answers are on a hybrid level (Figure 35).

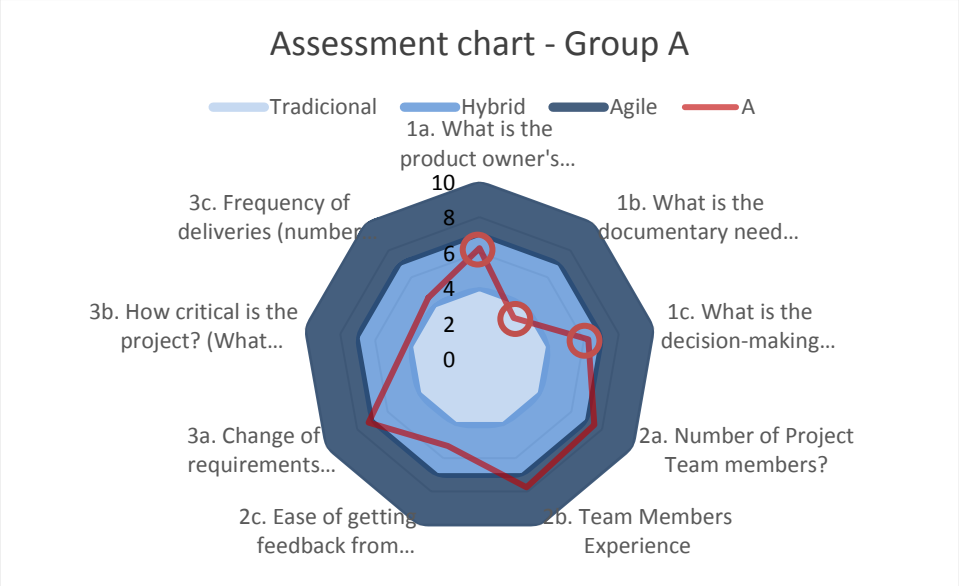

Figure 35 - Assessment chart Software development 1

If the organizational culture field has traditional points, the team field is mostly agile with two of the three questions in that area (Figure 36).

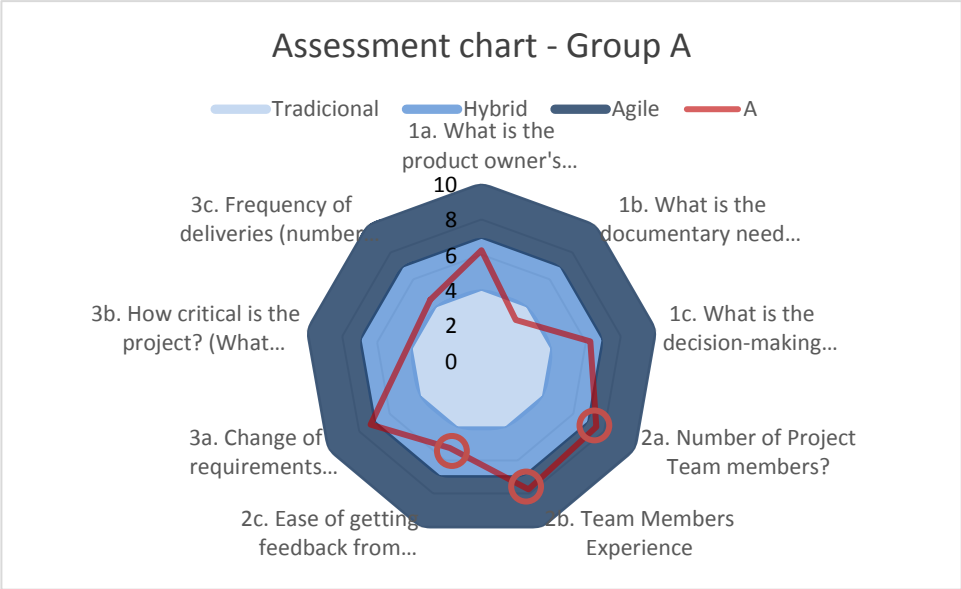

Figure 36 - Assessment chart Software development 2

Finally, on the project matters, the results are mostly high hybrid with agile variations (Figure 37).

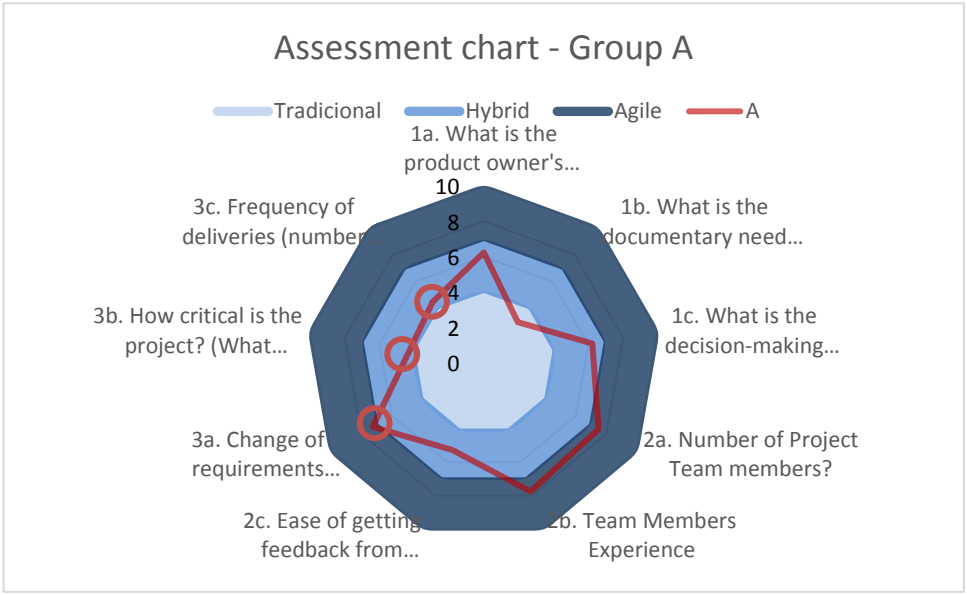

Figure 37 - Assessment chart Software development 3

4.5.5 Group B - Implementation results and conclusions

For the organizational culture field, the main fact that can be pointed out is the need of documentation at the department, as well as with group A. Both groups had close results on this matter (Figure 38).

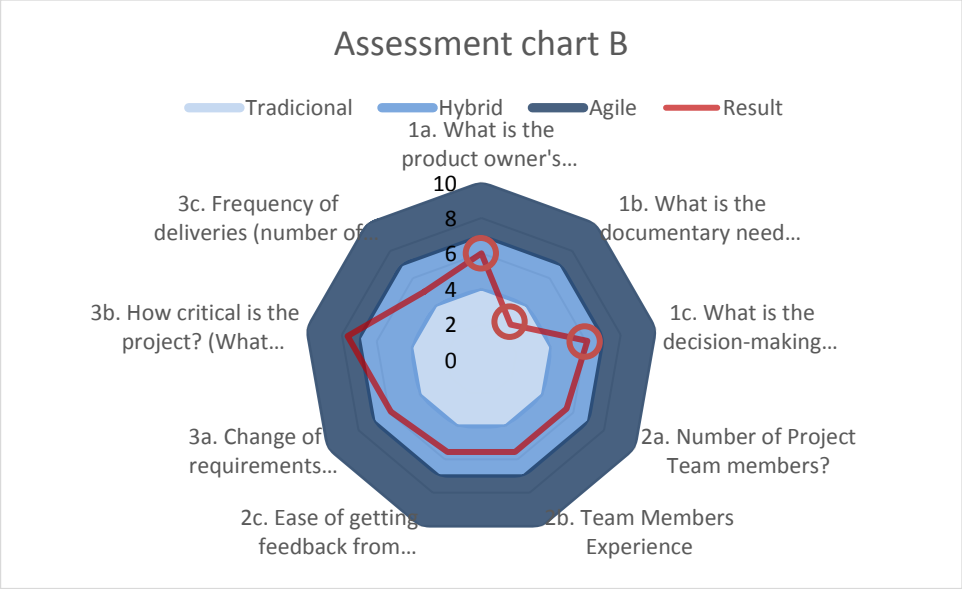

Figure 38 - Assessment chart implementation projects 1

If the organizational culture field has traditional points, the team field is mostly hybrid. Comparatively to the group A, this one obtained result with less agility (Figure 39).

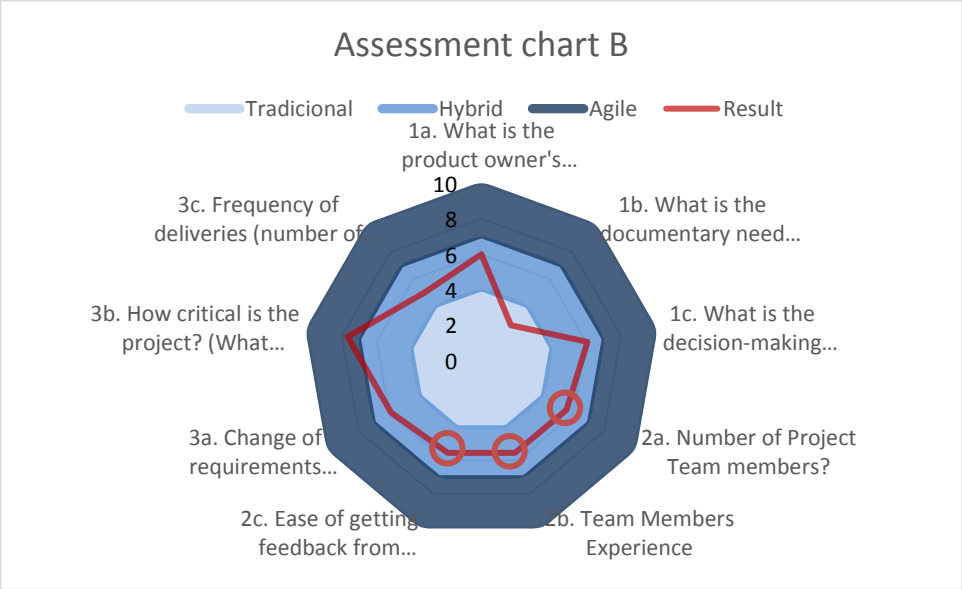

Figure 39 - Assessment chart implementation projects 2

Finally, on the project matters, the results are mostly high hybrid with agile variations (Figure 40).

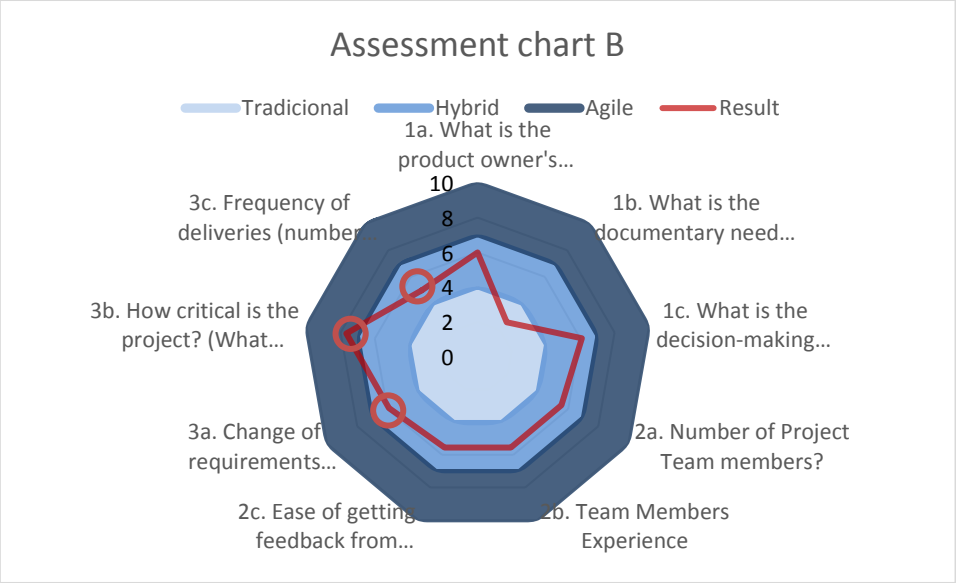

Figure 40 - Assessment chart implementation projects 3

Doing the comparison between the results of the two different groups (Figure 41) it is possible to draw some conclusions:

- Whatever the type of project the need for documents is always high.
- The remaining points follow mainly a hybrid methodology, and the two groups are very similar, except in two aspects.
- The first difference between the groups is that the software development projects have higher rate of change of requirements.

- The other difference is the higher criticality of the implementation projects.

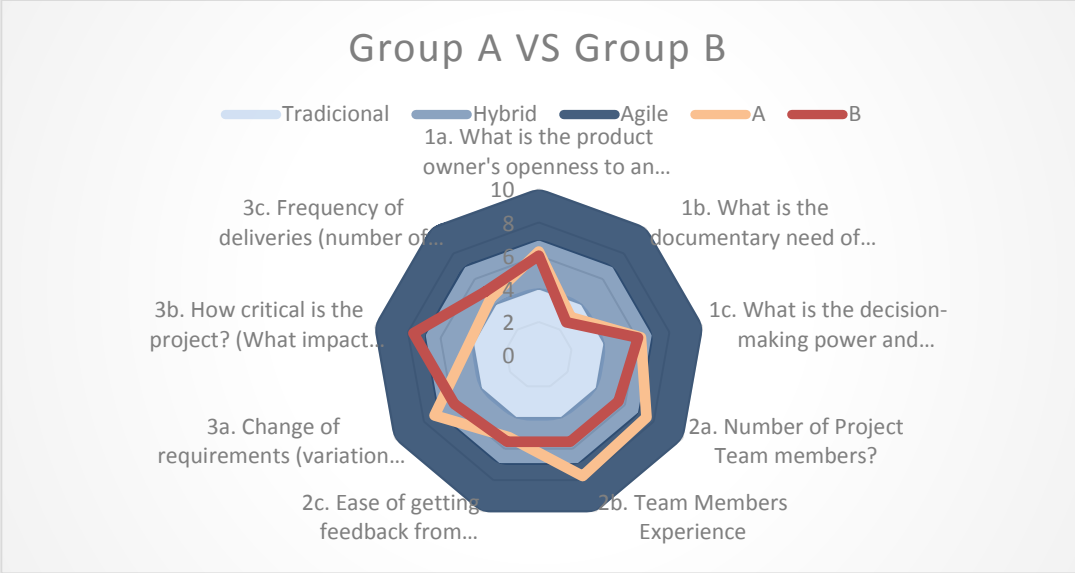

Figure 41 - Comparative assessment chart between the two types

4.6 Diagnosing phase conclusions

Before presenting the new framework and concluding the diagnosis, it is important to outline some points and conclusions:

- The project management strategy consists on giving priorities to projects that are meant to fulfill costumers needs, for a quick answer to specific requirements;
- The framework was designed considering the different types of problems that were found;
- It needs to be adapted to the reality of the department with either predictive or agile characteristics, which means that the framework may follow a hybrid approach.

5. PROPOSAL PRESENTATION

This chapter has the main goal to expose the proposal of the framework designed for the ongoing and future projects of the department, solving this way the problems that were identified before.

Following the structure that was previously defined for this dissertation, and having the problems been exposed and dissected, it was time to elaborate a concrete proposal based on the resolution of the identified problems and adapted to the department.

This chapter is organized in five sections and it begins with an overview about initial considerations and assumptions that is important to take in consideration, in order to understand the framework. Then, the project management strategy is presented. A global overview of the framework is presented next, and then each phase is specified. Doing the bridge between what was clarified in the introduction, this is the beginning of the action planning phase of the action research cycle (Figure 42).

Figure 42 - Action Planning phase

5.1 Initial considerations

Firstly, it is important to present some considerations and assumptions that were fundamental for this research, and to understand the way of work of the proposal.

- Regardless of the fact that this framework is meant for projects, the PMO (Project Management Office) of the department had characterized four department functions: projects (main theme of this study), operational functions, support functions and others. Functions are all the different tasks that any member of the department can have, and these are the groups that are able to categorize each function. The idea of

this division is to propose a global framework which purpose is to serve as a base for the different activities, which has the particularity that can adapt itself to each group.

- Project type organization: This topic was an important issue, once it was the base for the future steps. On the previous framework, the different projects were classified as “software development projects” and “implementation projects”. It was this division that was used on section 4.5 in order to understand which the needs of the new proposal were. However, it was proposed another organization that can reflect better the different natures of the projects named R&D projects, Proof of concept (POC), Pilot projects and Yokoten projects (Figure 43).

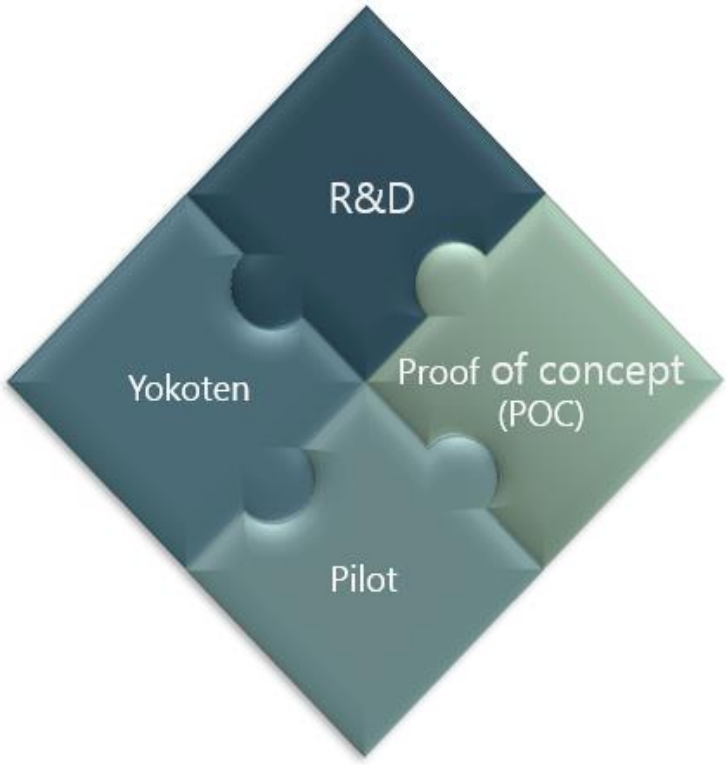

Figure 43 - Types of projects of the department

R&D projects is the abbreviation for research and development projects which refers to innovative activities undertaken by corporations or governments in developing new services or products or improving existing services or products. On the department, this specific type is normally attributed for technical teams dedicated to innovation processes.

Proof Of Concept (POC) projects are a realization of a certain method or idea in order to demonstrate its feasibility, or a demonstration with the aim of verifying that some concept or

theory has practical potential. This type is widely used and it appears normally after the R&D projects. First the research than testing its feasibility on a specific context, usually using inputs that are not completely trustworthy, it is used a lot for testing the concept in extreme situations.

Pilot projects are those projects that normally choose a specific element (normally on the shop floor) to apply a concept. The difference for the POC is that in pilot projects the data is reliable and real situations can be tested.

- Yokoten is a Japanese word that roughly translates to best practice sharing. The term Yokoten was adopted to capture the idea of horizontal transfer of information and knowledge across an organization. Normally it arises after the types that are above described, because it is the transition of an example to all the elements of the scope. Like was said before, the scope of this study was the proposal of a new framework for the management of projects, however, it is inserted on a bigger strategy of reformulation and standardization of activities and practices. Figure 44 represents the strategy and division that the team idealized. As it is possible to imagine, each function, and going even further, each type has a way of working, so the approach was to always define the generic roadmap for the framework, with the possibility of specific changes in each group.

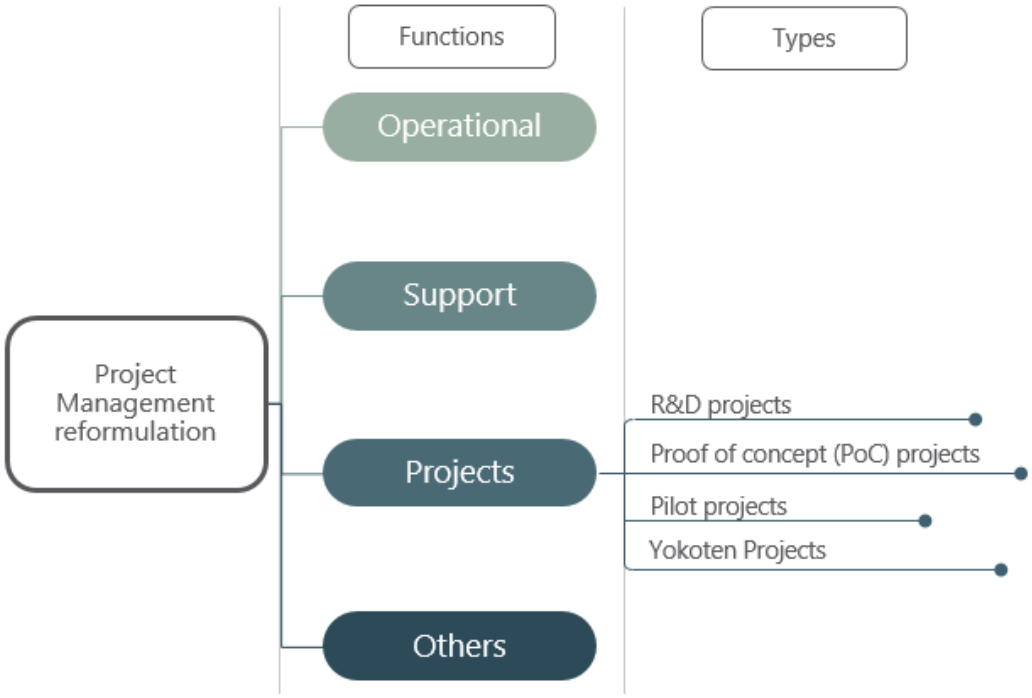

Figure 44 - Project Management organization

- According to the different types of projects, different "paths" of the framework were created. Even though the framework has a structured line of thinking, for the different types, the framework has some differences among them.

5.2 Project Management Business Strategy

As it was said in section 4.1, projects have three different origins: Strategical projects, Continuous improvement projects, and Costumer requisition projects.

Contrarily to the situation that was found, this strategy should be redefined to something like what is represented on the Figure 45 where the priority should be strategical projects, then projects of continuous improvement and, in the end, specific projects for costumer requisitions. This chain is much more flexible and capable of responding to changes of

requirements from the costumers and allows the increase of competitiveness among the other competitors.

Figure 45 - Project Business Strategy II

5.3 Framework structure

Framework structure was the name created to identify and present each methodology represented in each project phase. According to PMI (2017) a project can be divided in five different phases: Initiation, Planning, Execution, Control and the Closing phase (Figure 9).

Some authors and methodologies do not consider this project structure, however the names that are given mean the same. For that reason, this will be the bottom line for the construction of the framework.

A project management framework has the flexibility to be adjusted to the project needs, goals and constraints. A framework can have many phases and many processes per phase, where a process transformation takes place every time a new project is introduced (Markopoulos et al., 2008).

Process frameworks are characterized by the agility concept. In frameworks there is a method, an approach, a standard, a philology, a logic, but no strict rules, specific phases, specific process or process dependencies (Markopoulos et al., 2008).

The structure of the framework was inspired on the good practices explained in PMBOK (Figure 9).

The framework is composed by six different phases and five different milestones and it is presented in Figure 46.

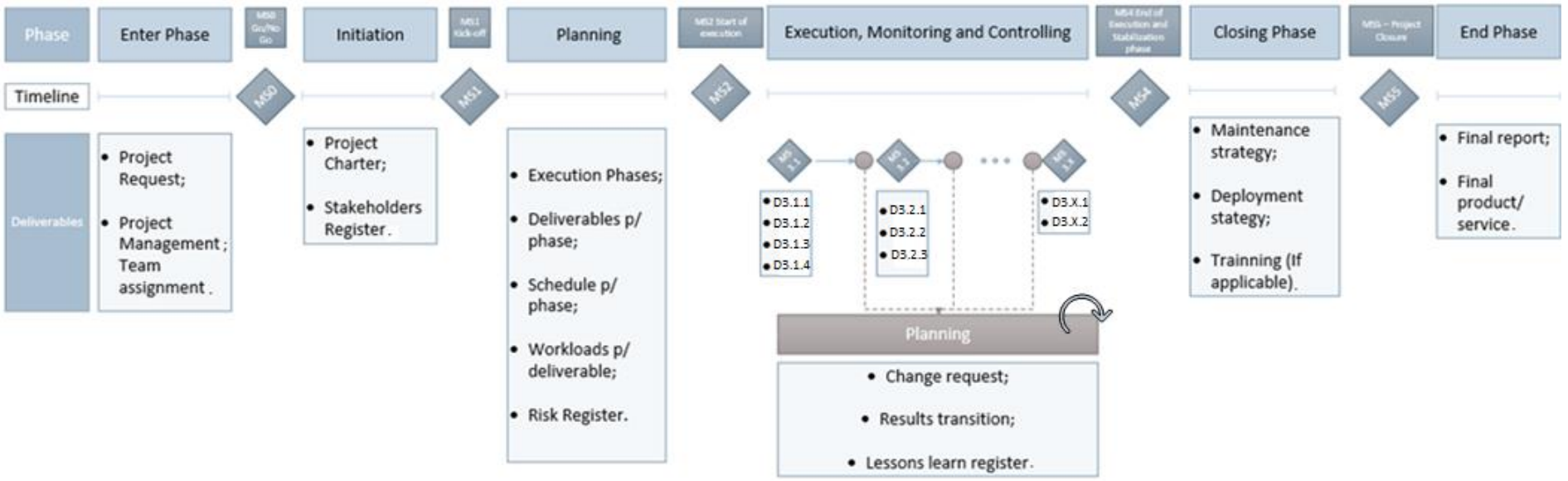

Figure 46 - New Framework for the management of projects

5.4 Framework phases

In the next section, the characteristics and the procedures applied in each phase of the construction of the framework will be explained step by step, and a final summary of the new framework will be presented. In addition, whenever necessary, a bridge between the proposal and the data that was collected on the diagnosing phase is built to ensure the adaptability from the new framework, to the characteristics and problems of the department.

5.4.1 Project Management Strategy

According to the results of the suitability assessment chart presented in section 4.6, the new framework must follow a hybrid approach with heavy documental needs attached, due to the company structure and difficulty of the flow of information.

Taking in account the different project management strategies presented in section 2.1.1.3, and the facts mentioned on the paragraph above, the strategy that was proposed was the Iterative for the management of projects.

The methodology can be seen as an Iterative approach, mostly because of the facts that are explained on the section 2.1.1.3, where it is said that an iterative lifecycle or strategy allows to group the work into time boxes where each box is target of evaluation, with the possibility of improvement from a time box to another.

5.4.2 Enter Phase

In this section it is explained the beginning of the processes of the new framework. This is an introductory phase, on which the project request is developed and the assignment of the project team is done. Most of the projects that started during this research came from an idea of someone who talked to a co-worker being considered the right person to handle the idea. It is proposed that this should be documented on a document called Project request. This is an important phase because it is here that is discussed if the project can bring future improvements or not, since the Milestone 0 – Go/No Go is the next step.

5.4.3 Initiation Phase

In the management of projects all phases are important, nevertheless, it is important to remember that in this research, 75% of the problems found came from inconsistencies of the

Initiation and Planning phases. For this reason, this phase embodies other dimensions of importance.

It was stablished that the project charter is one of the important tools of this phase and it should be sent from the person that had the idea to the appropriate project manager, via email, with the information of the type of project, the idea and some improvements that would be taken from the idea.

The next step is made by the project manager which role is to understand if the idea is doable.

Then there are two ways to present the project to superiors in order to get approval. On the Point CIP (Continuous Improvement Process) weekly meeting or on the Steering Committee.

The Point CIP is a weekly meeting that usually is made with the collaboration of all the members of each team where each one can discuss new ideas and problems that were found. On the other hand, the Steering Committee is a round of meetings, which usually takes place once a month, gathering the responsible for the departments in order to present new deliverables and align the next steps. The difference between these two is that the Steering Committee is more formal and with people with more power on the decision-making process.

From this presentation several conclusions can be taken. If the project request is not ok, the idea is cancelled. If it is ok, this presentation will have the feedback and the guidelines that the project must follow in order to succeed.

If the guidelines are agreed upon by all involved, it is time to define the team members and their roles and responsibilities.

The moment that the team is identified is the first milestone called the MS0 - Go/no Go and with this the enter phase is finalized (Figure 47).

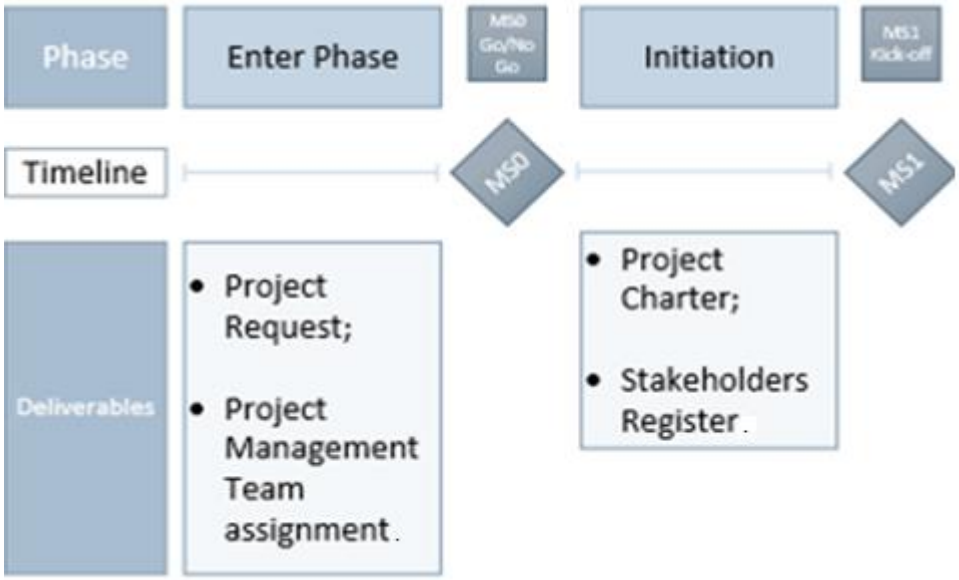

Figure 47 - Enter and Initiation phases

The initiation is characterized by two main documents: The project charter as suggested in Figure 47 and the stakeholder's register document.

The project charter is a document that needs more information and detail compared to the project request, being this the first version of the project charter. One more time, is important to point out that it is important to simplify processes and eliminate wastes, whereby the transformation of the project request into the project charter allows the elimination of unnecessary documentation and repetitiveness of answers (information that is explained in more than one document).

The project charter themes of answer are described on Figure 48.

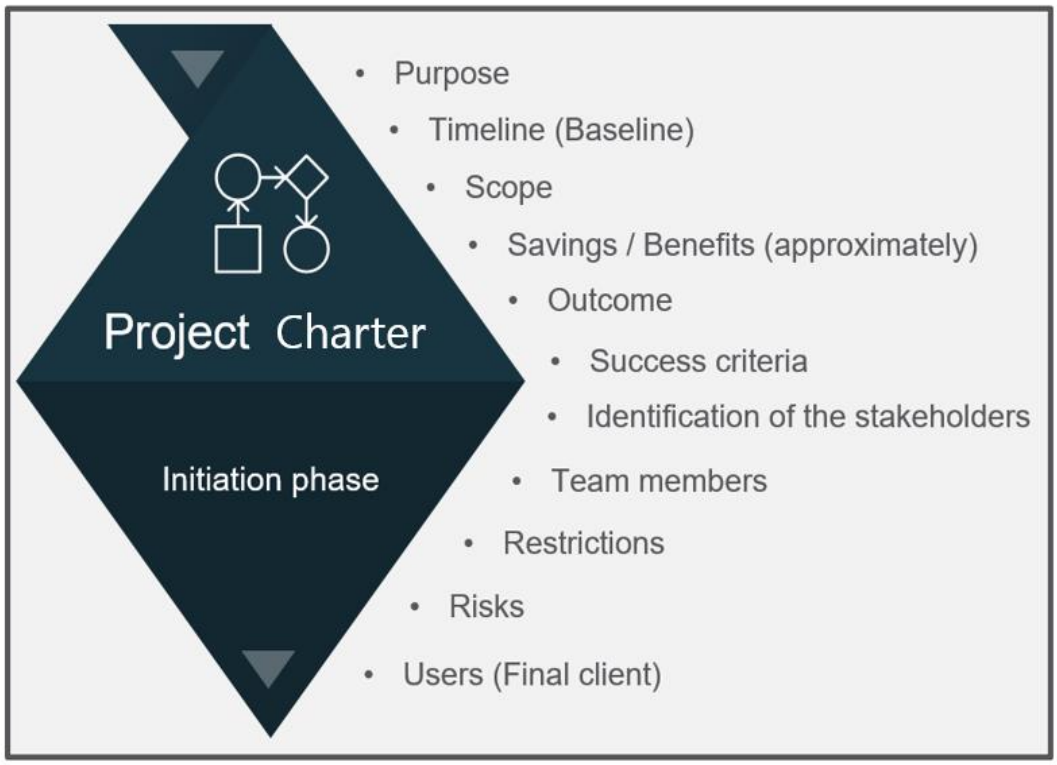

Figure 48 - Project Charter areas

In section 4.6, Diagnosing phase conclusions, it was concluded that the documentation needed in the company is high whatever the type of project, and in this phase it is possible to see the documentation need, that was identified, being fulfilled. In the next sections each one of the project request elements is going to be explained.

- **Purpose**

The purpose of the project needs to be explained and needs to be explained to the team

members. The purpose is the fundamental reason for initiating the project, leading it to reach the main goals. The purpose shows how much the project is beneficial for all the interested parts, being them the company, the product owner, the team or the end user.

The purpose should answer the next questions:

- Why are we doing the project?
- What is the intention of the project owner?
- What will be created, changed or enhanced?

- **Scope**

The scope defines what is inside and outside the project boundary. It is an important part for the alignment of expectations among the different parts. For instance, a good scope definition can prevent unnecessary disagreements regarding workloads and roles of each one.

The scope should answer the next questions:

  - Which areas should be covered with this project?
  - Which areas should not be covered with this project?

- **Success Criteria**

Success criteria indicate when the project purpose has been accomplished with a satisfactory result. The success criteria should be sufficiently detailed, in order to understand the line that allows identifying a project as a successful one.

The success criteria should answer the next questions:

  - What (goals/targets) should be achieved in order for the project to be successful?
  - What are the benefits of the project?
  - How will the benefits be measured?

- **Outcome**

The outcome captures what the project should lead towards identifying what is the output that is expected to reach. The outcome needs to be defined, because it influences the focus of the project. It should not be confused with purpose, which is the reason the project is carried out and the intentions of the project owner, whereas the outcome reflects the concrete desired result of the project. To deliver the project benefits and to fulfill the purpose, the project team must define the expected outcome of the project.

The outcome should answer the next question:

  - What do we want to deliver to obtain the purpose?

- **Team Members**

The definition of what was exposed previously about the composition of the project team.

- **Stakeholders Identification**

By definition, a stakeholder is a group or an individual, which is affected or affects the project. They are important because, usually they have resources for the project. Regardless the implementation of a stakeholder analyses further ahead, in the project charter it is important the identification of the complete group of stakeholders. In the stakeholders register document is described the communication flow and the importance/interest matrix.

- **Users**

The users are individuals or groups who benefit from the outcome of the project. The users are important, because they validate the reason for the project's existence. An absence of users means a lack of purpose and no justification to continue. Identifying users' needs, early in the project, will increase the chance of achieving the best possible outcome.

- **Restrictions**

Every project has restrictions set by its environment. This may for example be rules, procedures or standards, but also aspects such as time, money, technology, or knowledge.

- **Risks**

Risks are different from constraints in that they only have potential to occur. They can be defined as threats and opportunities. Every project holds uncertainties, which can affect it in both good and bad ways.

This analysis should answer the next questions:

  - What are the possible events or conditions that can affect the project?
  - What are the threats?
  - What are the opportunities?
  - How would risks affect the project?

- **Timeline**

The idea here is to present an overview about the main roadmap of the project, the dates of each milestone and some temporal boundaries. It is not needed a detailed schedule of the project development.

- **Savings/Benefits**

In a generic way, it is important to convince the sponsor about the benefits and the savings that the project will generate. This can be a tricky task because it is all about guessing the gains, however, is an important indicator for the partners and its alignment with the team.

It is important to clarify that the project charter is a document of extreme importance, since it is the place where all the project questions are answered. For that reason, it takes time and several meetings between the members to define the final version of the document.

Regarding to the Stakeholders Register document, it is divided into two different parts: the Communication Plan for stakeholders, and the Power/Interest matrix (Figure 49).

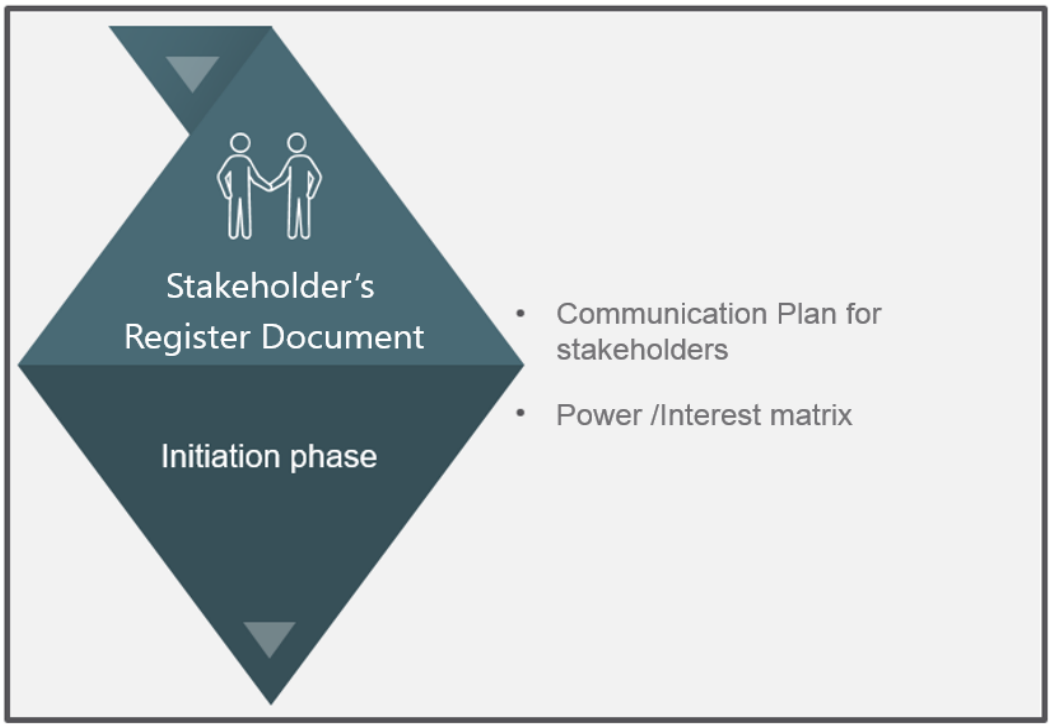

Figure 49 - Stakeholders Register areas

- **Power/Interest matrix**

The Power/Interest matrix is made for the team and it is about the people and organizations that are affected or affect your work. Some of these may have the power either to block that

work or to advance it. Some may be interested in what you are doing, while others may not care, so it is needed to work out who you need to prioritize (see an example in Figure 50).

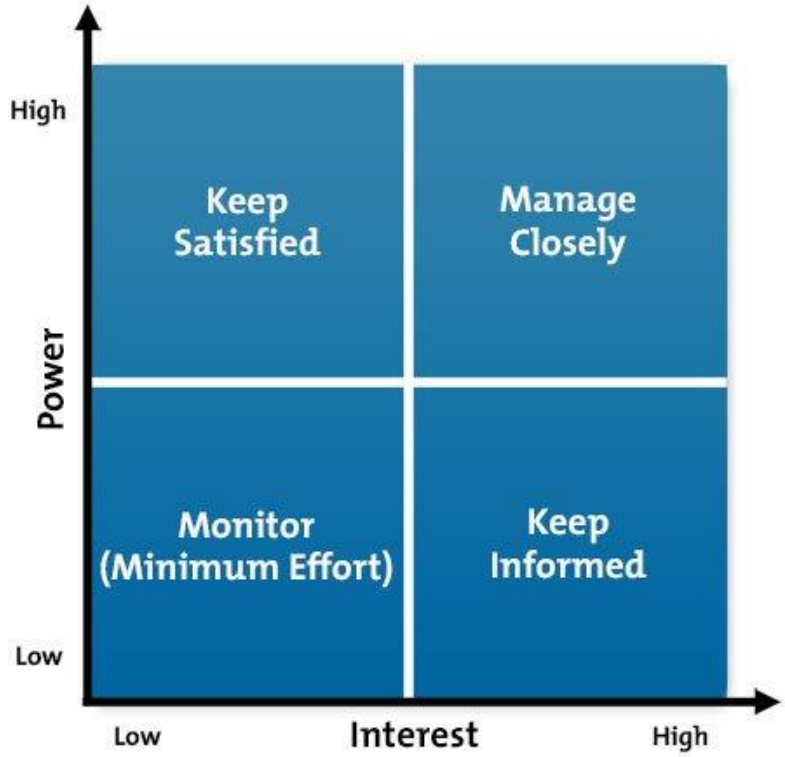

Figure 50 - Power/Interest matrix

Adapted from Mendelow (1981)

Communication Plan for stakeholders

This information establishes the plan of meetings and the flow of information for the different types of clusters of stakeholders. Depending on the group that the stakeholder is inserted, is the communication plan. In this plan, it is important to define key-players representative of a group of stakeholders to decrease the communication channels. The excess of communication channels can, sometimes, be thought as a major problem. For instance, if a project has a team of 5 people plus 2 groups of stakeholders each one with 4 people, there are 13 people involved in the project. Using the equation below, it is possible to conclude that there are 78 possible communication channels. This situation is going to bring loss of information and confusion to the environment. Well, with a proper communication plan and a defined strategy, for example electing someone in each group to be the key-speaker, the number of communication channels decrease for only 3 possible channels (1 element from the team and two others representing the other groups of stakeholders).

$$Communication\ chanels = \frac{n * (n + 1)}{2}$$

The Kick-off Milestone (MS1) is the point that marks the end of the initiation phase. The kick-off milestone is a meeting that aggregates all the key-players of the project, in order to validate the project charter and the stakeholder's register document, and also to define some important details and assumptions. This is a way to prevent indefiniteness of roles and responsibilities, since everything is documented and agreed on that moment.

At this time this is the proposal for the initiation phase, however, and following the ideas of lean philosophy and continuous improvement, if for some reason users end up complaining about the document load, it is proposed a workshop canvas. This workshop canvas is an exercise that gathers the team members, in order to, in an interactive and intuitive way, the questions that are on the project charter. The workshop can be made using an A3 white paper and post-its to complete the questions. This is other way to complete the initiation phase.

5.4.4 Planning

The next phase begins with the end of the MS1. At this moment, everything is defined, and it is time to prepare the plan for the project. According to Figure 9 that was based on the PMBOK (Project Management Institute, 2017), the planning phase is not static, it extends itself throughout most of the lifecycle of the project. In the same way, the planning phase proposed next is not static. However, it is possible to split itself in two different times. The first planning phase is characterized to be a macro one, and the other is the planning phase that happens in the end of every iteration (process that is explained further ahead), because the constant change of project requirements.

This process is explained having a first sketch of the timeline and the first version of the backlog of activities and main deliverables of the project. Then, it is only a matter of organizing all the inputs in different phases. These phases are boundaries that the PMO team thinks that will serve to guide the projects of the department. The boundaries will vary depending the project characteristics, however this is a task where the PMO can help and support the project managers of the department.

The last input for this phase has to do with the ability to make the effort of each activity or deliverable measurable. Assigning workloads to each activity allows a reasonable division in phases. The technique used for the planning is the Rolling wave planning.

The rolling wave planning is by definition, an iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level. It is an iterative planning technique in which the work to be accomplished in the near term is planned in detail, while work further in the future is planned at a higher level.

During early strategic planning when information is less defined (Planning phase), work packages may be decomposed to the known level of detail. As more is known about the upcoming events in the near term (Execution, Monitoring and Controlling phase), work packages can be decomposed into activities (Project Management Institute, 2017).

To recap, the idea is having the project start and finish date, the backlog of activities/deliverables, the workloads of each deliverable, and the number of phases needed, it is possible to organize the phases in time and workloads (Figure 51).

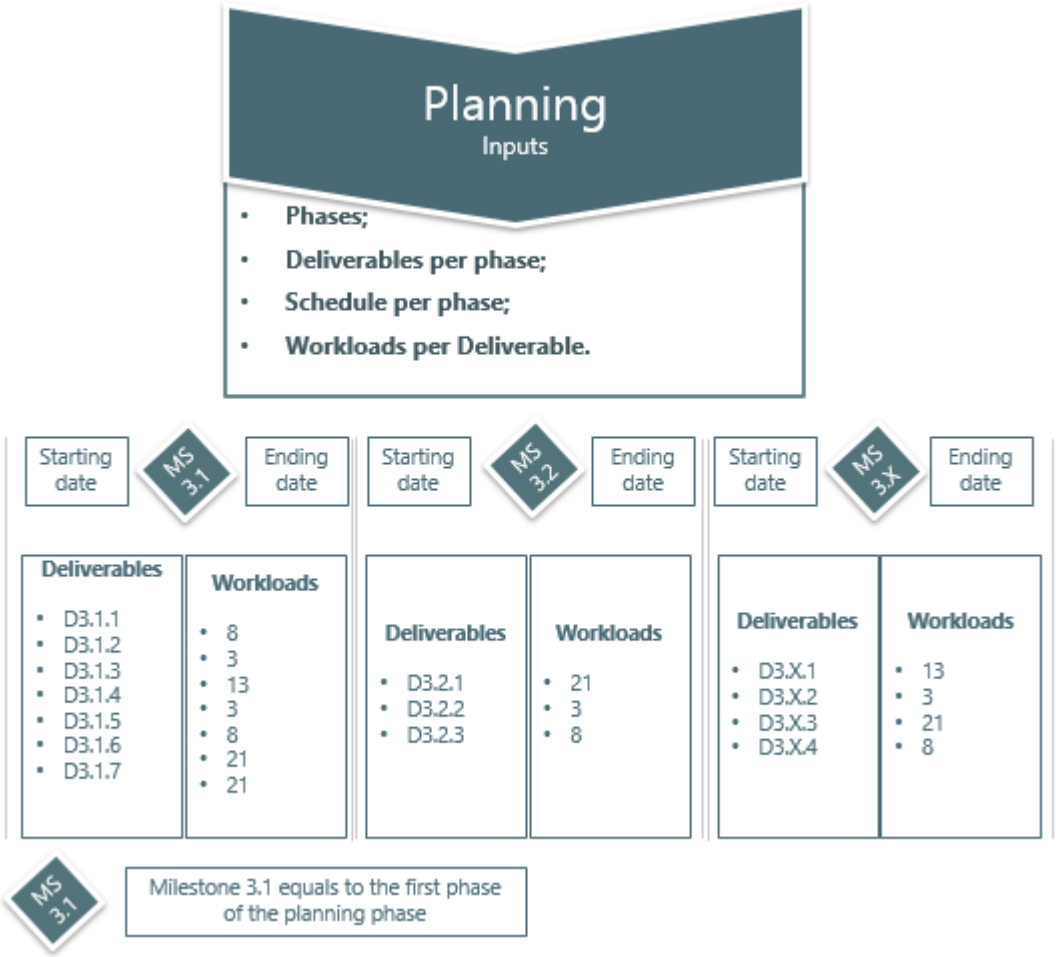

Figure 51 - Planning example

It is important to say that the plan is more detailed for the phases that are closer to that date. The attribution of the workloads is a hard task, which can be performed with the help of the PMO team of the department. The Milestone 2 named as start of execution is the milestone that finishes the first planning phase.

To conclude, it is important to refer that, due to the dynamic characteristics of the projects and their changing requirements, the phases can overlap. In other words, two milestones can be open at the same time, and both will have different speeds (next section).

5.4.5 Execution, Monitoring and Controlling phase

According to multiple methodologies, this phase should be named as execution phase, however, and due to its iterative characteristics, the name is Execution, Monitoring and Controlling phase.

At this point of the framework, the project team should have all the deliverables of the Enter phase and Initiation phases completed, as well as the macro plan that was developed in the previous phase. The Milestone 2 that was referred before marks the start of execution of the project.

Like was said before, this framework follows an iterative strategy with different iterations that are characterized by the different phases determined before. Nevertheless, to have iterations it is needed to insert an evaluation point between the phases. This evaluation point is made by change requests if necessary, to change the scope and lessons learned, which is an evaluation that is made at the end of the phase that can change something related to the project. The change request is usually presented in the Point CIP meeting or in the Steering Committee, depending on the dimensions of the change. After a change request, the plan for the next phase can be modified in a new micro planning period (Figure 52).

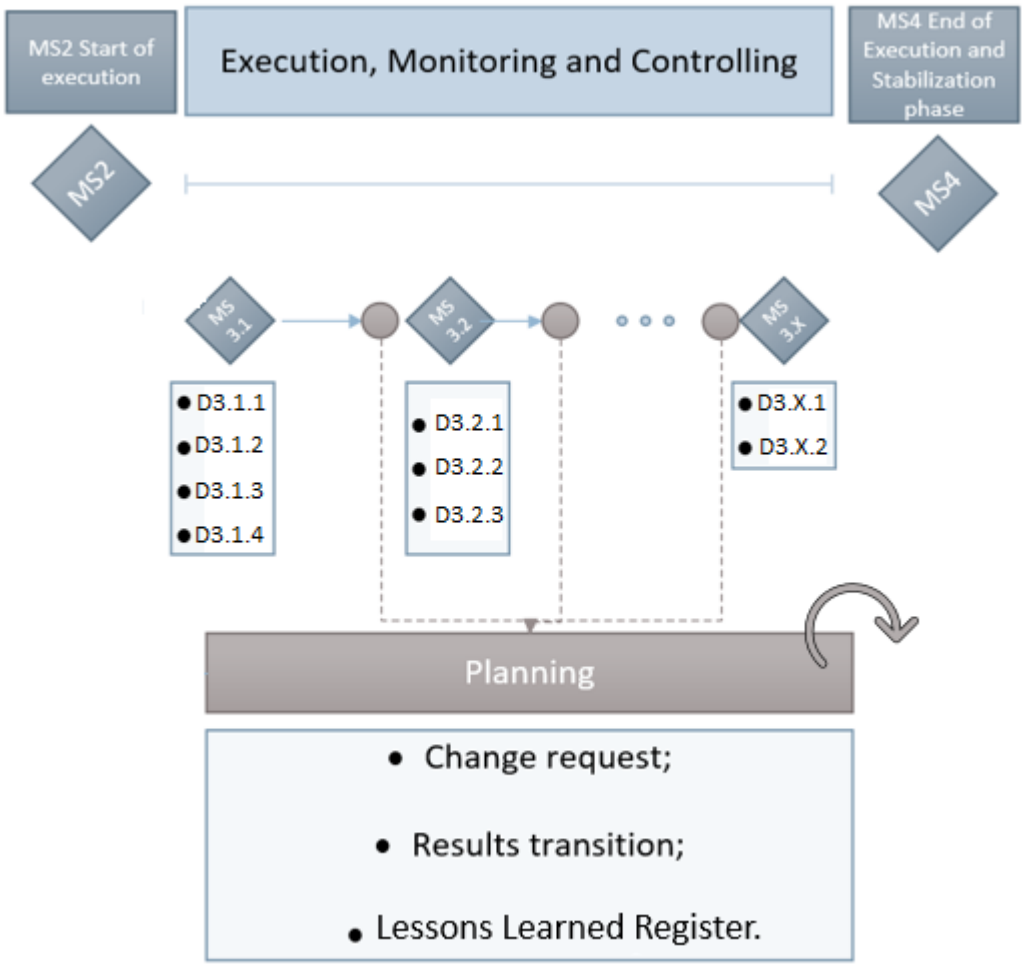

Figure 52 - Execution, Monitoring and Controlling phase

With the start of the execution, urges the need to organize the team members of the different projects. At this phase the control is made by two different ways. The first one is the control that is made usually at the beginning of each phase called planning control, and the other one is related to the monitoring of KPI's called performance control (it will be explained further ahead).

5.4.4.1. Planning control

The planning control is the section that deal with the flows of information and organization among the project team members. It is organized in two layers where the first one is responsible to organize the team week by week and the other one is a medium/long term organization. These are described in the following sections.

5.4.4.1.1. Weekly management – Project White Boards

Alongside the development of the framework, during the internship at Bosch Car Multimedia (BrgP), a new project was born called White boards project. A team of six employees was gathered and the author of this master thesis was assigned as project leader for this project.

The White boards concept came from the need of visual management of projects in each team by the entire CM/LO team. The project had two major goals: the first one was to allow the continuous update of the projects to the entire CM/LO team, using these boards, and the second one was to allow and ease the management of weekly tasks for each team.

Besides that, it was also required a standard template that could serve most of the projects, even though the differences among the projects are evident. These differences exist due to different requirements and consequently different needs of each team.

For these reasons and singularities, it was suggested, not a standard template, as it was expected, but a set of standard tools. A White Board is a set of standardized tools, which are grouped on a specific area, in order to attend all different projects' needs and requirements. The tools are:

- Timeline:

The first tool is called timeline and comes as a response to the main objective of the project, visual management.

It is basically a temporal line divided into steps which are the phases of the projects. These phases are previously identified by the project leaders, and will represent, not only the current state of each project, but also the state where the project should be, according to the time management planning.

As a major output, the timeline gives to CM/LO an overview of the projects that are on time, ahead or delayed in comparison to time schedule. This visual perception gives a greater awareness, not only to the team members, but also to the supervisors, who can increase or release resources, depending on the status.

- Kanban board

This second tool serves the purpose of the weekly management. The Kanban must meet the needs of the team, but always be aligned with the main goal. Thus, the elements can be different from team to team, according to their requirements. In order to have a standard, five elements are pointed out and explained as follows: “To do” represents the tasks that the team has to perform. “On going” includes all the tasks that the team is working at the moment. “Blocked” stands for the tasks in which the team depends on an external factor to proceed. In case that the team cannot move forward due to an internal factor is called a “Problem”. Finally, all the tasks that were completed are moved to the “Closed” field, until the next regular meeting occurs, when these tasks are removed from the board.

A task starts in the “To do” column, then goes to “On going” and the next step can be “Blocked”, “Problem” or “Closed” if no setback has occurred (Figure 53).

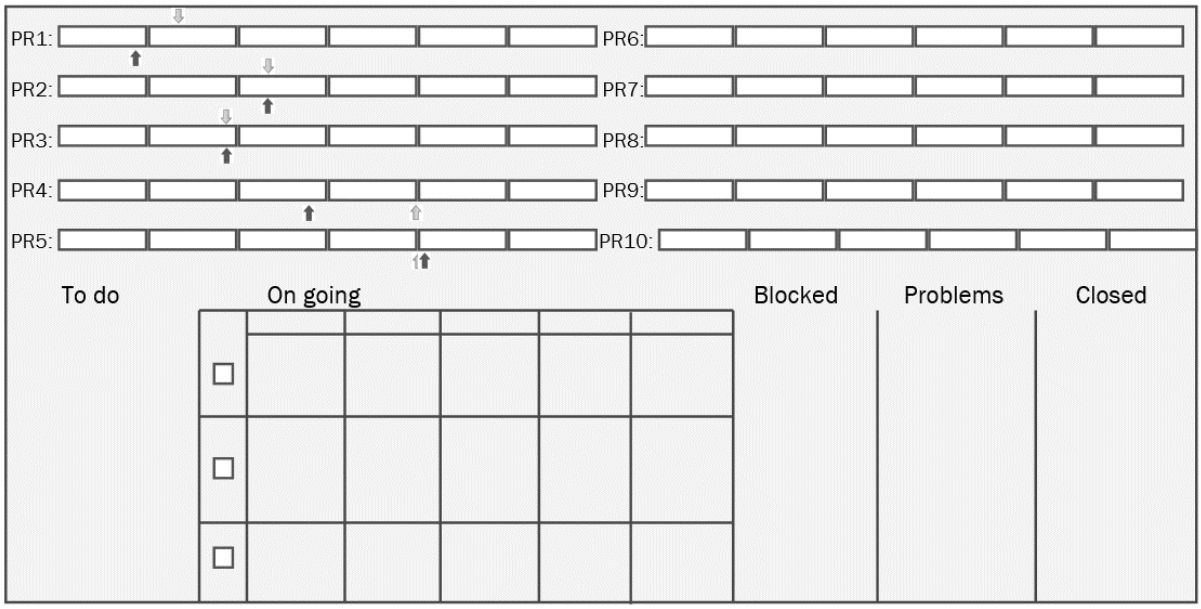

Figure 53 - White Board example

In addition to this dynamic, it is proposed that each project team and each project manager find a proper dynamic to the flow of information within the team. However, what is proposed is the implementation of daily meetings near to the respective whiteboard where each member can answer to these questions:

1. What have you been working on?
2. What are you working on today?
3. Do you have any problems or impediments to making progress?

These questions were based on the studies of Griffiths (2004).

5.4.4.1.2. Medium/long term organization

With medium/long term organization, what is meant is the purpose of a place to work and to organize each step of the team and its roadmap for the future. This one is a topic that, just like others, needs a certain level of maturity for the framework, and for that reason this is not a proposal for implementation. The proposal is presented in section 7.2, as future work.

5.4.4.2. Performance Control

You cannot manage what you cannot control;

You cannot control what you cannot measure;

You cannot measure what you cannot define.

Adapted from (Cheng, 1994)

The performance control is the other section of the control phase that is responsible to indicate some KPI's, namely:

- **Project Speed**

The speed of the project is an indicator that can give some insight about the speed that the project is having. The speed can be measured having into account the predicted dates of closure of either each phase or the project closure, and the beginning date. The speed on each phase depends on the percentage of workloads done per the percentage of time that has passed since the beginning of the phase. The workloads can be determined per phase depending on each deliverable that are supposed to deliver at each specific time of the project. In order to understand the logic behind the construction of the KPI´s, above is presented an example. On the next example it is important to presume some information. A specific phase named X has associated seven different deliverables with different workloads (Table 5).

Table 5 - Example Deliverables and its workloads

Deliverables	Workloads
D x1	8
D x2	3
D x3	13
D x4	3
D x5	8
D x6	21
D x7	21

The starting date of the phase is 15th of August, the end date is 15th of September, and the current date is the 27th of August. This means that the number of days predicted for the phase is 31, the number of days that already passed since the beginning is 12, and the number of

days for the predicted end of the project is 19. Following that logic, it is possible to say that the percentage of time that passed is 39% (Table 6).

Table 6 - Example 1 dates

Initial date	15/8/2019	Days since the beginning	12
End date	15/9/2019	Days until the predicted end	19
Current date	27/8/2019	Percentage of time passed	39%
Toal days	31		

Another important input that is possible to point out from the text is the percentage of work that was done at this day, which is 45%.

$$Speed = \frac{\%\ of\ workloads\ done}{\%\ of\ time\ that\ passed}$$

The meaning of the result indicates indirectly if the projects are delayed or not. The scale of results varies from 0 and do not have a maximum limit, and if the result is lower than 1 it means that, with the same pace, the project will be late. If the result of the speed is more than 1 it means that the project probably is loose on time. In the example presented above, the Speed is 1.17, which allows us to understand that, at this day, the project is on time.

However, it is difficult to understand what the practical effect of these numbers is. That's why the next KPI was created.

It is important to warn that this process relies on the accuracy of the assignment of workloads to the different deliverables. To increase this accuracy, the PMO team of the department will have an important role to support the project managers.

- **Project Delay/Slack**

This is the other KPI, which is attached to the project speed. To reach this value, first it is necessary to calculate the number of days that, at the current pace, the project or the phase is predicted to finish. Then it is easy to predict if the phase or project is on time or not.

Taking the example above explained and seeing that the speed is 1.17, it is expected that the next KPI is positive, or by other words, the project will be ahead of schedule.

A way to quantify this is taking into account the pace that the phase already has. In this example, five deliverables (the sum of the workloads is 35) were completed in twelve days. Dividing them, the result is 2.92 workloads per day. Well, if the pace is 2.92 workloads per day, it is expected that for the remaining 42 workloads the phase will last for 14.4 more days. Adding these 15 days, rounding up the value, the final date is 10th of September. Since the predicted date for the end of the phase was 15th of September, it means that, at this pace, the phase is 5 days ahead of schedule (Table 7).

Table 7 - Example 1 results

Workloads done (%)	45%
Speed = % Workloads done / % Time spent	1.17
Real workloads at this pace	2.92
How many days to the end at this pace	14.4
End date at this pace	10/9/2019
Delay or Slack of the phase	5.0

The sum of the values of this indicator per phase results in the overall delay/slack of the project. This happens because of the possibility of overlapping of phases on time.

$$Delay\ /\ Slack = Ending\ date\ (planned) - Ending\ date\ (pedicted\ at\ current\ Speed)$$

The two indicators that were presented have a direct relation between them. For instance, if a phase of a project has the speed at 1.17, that means that the slack of the phase is 5 days as stated in the example. On the other hand, taking in account another example, where the speed value is 0.83 it is possible to determine that the delay is 7 (Table 8).

Table 8 - Example 2 results

Workloads done (%)	45%
Speed = % Workloads done / % Time spent	0.83
Real workloads at this pace	2.06
How many days to the end at this pace	20.4
End date at this pace	21/9/2019
Delay or Slack of the phase	-7.0

On its turn, if the speed is 1, it means that the phase is on time, without any delay or slack to the end date. This phase ends with the Milestone of End of execution and Stabilization phase (MS4).

5.4.6 Closing

Regarding the fact that, at this phase, most of the work is done, this is an extremely important phase, which usually does not have enough effort of the department. The closing phase of this framework starts with the Milestone MS4 – End of execution and Stabilization phase. Like it is possible to understand, this is a phase meant to develop processes of stabilization, namely maintenance, deployment and training strategies.

It is possible to argue that these stabilization strategies depend on the nature of the different projects, however, this is just a standard of tools that may help the project manager, and the PMO department can help and support these questions.

Maintenance strategy – If a project is well developed, with all the features and characteristics working, it may seem that it is closed, however if the plan to maintain the project tools or functionalities does not exist, all the efforts can be in vain. A proper maintenance strategy is responsible for a seamless stabilization of the project. At this stage, preventive maintenance rules are defined, just like the action plans in case of failure.

Training – The training or the education of the end user is a crucial part of a project, since the project cannot reach the success criteria if the end user is not trained for the new functions. In other words, it is possible to say that the project success depends on the right training.

Next, the final Milestone happens, MS5 – Project Closure, with the final deliverables, a final report and the new product or service.

Deployment strategy – By definition the deployment of something is the group of activities that make the product or service available to use. This topic is related with the division that was explained in section 5.1 because the division is oriented to a sequential project type. It is proposed that an idea should follow the path: first the R&D project; then the PoC project; then the Pilot project; and then the Yokoten project. The deployment strategy is made to clarify these barriers and the strategies and timings needed to follow this division.

5.4.7 Framework Milestones

Through the review of the framework it is possible to find some milestones, which are going to be explained on a summarized way in this section.

There are at least 5 different milestones, one at each change of phase. It is at least, due to the iterative strategy applied on the Execution, Monitoring and Controlling phase, where at the

end of each iteration, there is one sub-milestone. The transition from the Enter phase to the Initiation phase is made with the Milestone 0 – The Go / No Go. It determines if the project will be born or not, based on the information of the Project Request and the Team assignment. Then we have the kick-off Milestone 1, that is between the Initiation and the Planning phase, on which is the formal presentation of the project for the stakeholders with a well-structured Project Charter. The Milestone 2 is the Start of Execution, where the plan is done. During the execution, there are a number of sub-milestones at the end of each iterative cycle, where it is discussed the Lessons Learned, if there are any Change Requests, and to give the plan for the next iteration. At the end of this process is the Milestone 4 – End of Execution and Stabilization phase, which marks the end of that important phase of the Execution. Finally, the last one is the Milestone 5 – Project Closure, with the delivery of the final product or service from the project to the client. At this phase the product or the service is stabilized and at perfect working conditions.

5.5 Proposal chapter conclusions

This section comes like a conclusion after the presentation of the proposal, since it is important to define some aspects.

Firstly, it is important to remember that this study followed an action research methodology. From the five phases that are characteristics of this methodology, due to the lack of time, the research only reaches the third phase – Taking Action. The next phases of Evaluating and Specifying the Learnings, presuppose time to evaluate the tool. Instead the possible alterations are proposed in section 7.2 (Future Work). Furthermore, it should not be forgotten that the Diagnosing phase is explained in chapter 4, the Action Planning is in the fifth chapter and the Taking action was developed in the department following the plan previously detailed.

Another thing to point out is that this is a draft version of the framework, which is going to be target of continuous improvements during the time, in order to make it a more robust framework.

Like it is stated in section 4.6, it was required to follow a hybrid approach for the framework. It is easy to identify the various artefacts from the PMBOK and consequently of the plan driven or traditional methodologies, however the framework is considered hybrid because of the dynamic phase of execution and monitoring phase. Analyzing that phase, it is possible to find

a lot of similarities with the Agile framework named Scrum, where the ideas and the main framework was inspired. The differences are only the names that were given, for example instead of sprints, it is called Milestones with deliverables to reach, but the idea and the procedures are similar. This is the reason why the framework can be classified as a hybrid framework.

The framework was, at the time of the end of this research project, starting to be implemented at the department, however, and due to the lack of time, only presumable results are described below.

6. RESULTS ANALYSIS

In this section, the expected results of the effects of the proposal is presented. Due to time constraints, only some steps of the framework were taken, so mainly expected results are analysed. It is important to say that due to the specific characteristics of the project, the results cannot be presented on a quantitative way. A new way of work for a department was the main output of this project, and despite the undeniable importance of the project and its impact, the results are not quantifiable. This section is structured reminding the problems that were found in section 4.4.2 and comparing them with the situation after the implementation of the framework. The list of problems that were chosen were the ones from Table 4, since the problems related to the management of projects are the ones that matter the most. To allow a better understanding of the context, that problems from Table 4 were divided by the objectives of the section 1.2. For each objective, the tool 5M1E was used in order to organise the problems. The abbreviation stands for Management, Method/Measurement, Machines, Materials, Man and Environment, even though none of the problems could suit on the Machines category.

6.1 Instill project management processes (Management)

The next sections are related to questions that can fit on the management issues.

6.1.1 Improvement of schedule planning

With the implementation of an iterative strategy, the planning process became easier, reducing the difficulty reported in section 4.4.3. The plan can be designed without all the characteristics that were necessary previously, and at each increment, right before the start of each execution milestone, a new round of planning is made. With this is expected to achieve a proper planning that can reflect a lower degree of uncertainty of a plan for a project.

6.1.2 Better risk management

The Risk management was one of the concerns that were mitigated with the new framework. The Risk management document is presented in the planning phase, and the new template is going to be developed as it will be referred in the next steps chapter just like the necessary

training sessions that the team needs, in order to improve the risk management practice. This measure will probably solve the problem.

6.2 Improve the planning of workloads for team members or stakeholders (Method/Measurement)

The next sections are related to questions that can fit on the method or measurement issues.

6.2.1 Visualization of actual state of the project

The lack of information within partners is a topic that depends on other factors, namely the level of commitment of the members. However, with the introduction of, not only of the Steering committees (with presentation of the projects developments) but also the whiteboards (visual exposition of the current status) helped to improve this topic. This measure will probably solve the problem, because it is expected that the actions allow a better integration with the stakeholders and on time updates about the projects.

6.2.2 Bad or inexistence of a deployment phase

Like it was said before, the deployment phase is now one of the parts that are on the new closing phase with the deployment strategy. With this measure it is expected that actions like the training of the end user, the project lessons learned, or the maintenance strategy, start to be made. All these actions bring advantages and it is expected that, with them, problems related to this area will decrease.

6.2.3 Bad definition and deficit exposure of project requirements

The answer for this topic seems to be the same that was answered above in the “Lack of information about the actual state of the project” topic. The steering committees and the whiteboards came to solve this problem. It is expected that these specific events, or the exposure of the whiteboards to the open space, bring more information to the stakeholders and the team of a project.

6.2.4 Inexistence of a communication plan

The plan for communications for different groups of stakeholders was done. This was the possible solution proposed for this matter. With a proper plan it is expected that the

communication channels start to be less, minimizing wastes of misinterpretation and repetitiveness of information.

6.2.5 Inexistence of a financial analysis

The financial analysis was not considered due to the maturity level that the framework needs to achieve. It was decided that the financial analysis would be added somewhere in the future, since the moment that the framework was introduced and the way of working of the department are stabilized.

6.3 Use of the same standards among all the projects (Materials)

The next sections are related to questions that can fit on the materials issues.

6.3.1 Lack of documentation and important information about the project closure

One of the biggest differences between the two frameworks is precisely the new way of closing projects with the characteristics that they need. The maintenance strategy usually supports the projects that interact with the shop floor and hardware, guaranteeing a clean closure. The same can be said for the training and the deployment strategy. This measure will probably solve the problem, since it is expected that the lessons learned from project closure to project closure act effectively avoiding the repetitiveness of problems.

6.3.2 Better folders organization

The documental disorganization was a general problem within the projects, however the framework did not cover this topic due to the fact that in parallel to this project, another one was being developed, which scope was to standardize the folders of the department.

6.4 Improve and define the roles and responsibilities for project management (Man)

The next sections are related to questions that can fit on the topic of man issues.

6.4.1 Lack of definition of roles and responsibilities

The assignment and acceptance of roles and responsibilities are always a difficult change for the partners. However, the stakeholder's management document can be one of the factors

that can help on this topic. The other one is the MS1-Kick of meeting, where the project charter is approved. On that meeting, all the roles, all the assumptions and all the tasks need to be defined. These measures can prevent problems and situations that came from this topic. It is expected that once signed, everyone is aware of the role that has to take on a project.

6.4.2 Bad management of resources

Resources here are intended to be Human resources and their capacity. This topic was mitigated introducing the project control workloads, that even though they are meant to be used for projects, they can be utilized by workers. This way each individual can accept or not the works of a new project regarding the workloads and capacity that the individual has.

6.5 Improve the overall quality of the projects (Environment)

The next sections are related to questions that can fit on the environment issues.

6.5.1 Better alignment of the stakeholders

The problem of lack of alignment by the stakeholders referred in section 4.4.3 could be improved by the creation of the stakeholders register document, the stakeholder's identification presented in the project charter, and the Power/Interest Matrix. Beyond this, with the new system of Steering Committees and Point CIPs the flow of information is easier. This measure will probably solve the problem, since it is expected that this more close strategy, bring a bigger awareness of the importance of the communication within project members.

6.6 Synthesis of the main results

However, it seems difficult to measure the results, it is possible to outline that 10 of the 12 problems are expected to be solved sooner. This means a rate of expected success of 83% (10 out of 12 problems). According to what was said on the section 4.4.1 on the semi-structured interviews, the same problem was diagnosed several times by different people. Looking to the number of times that a problem was identified on the semi-structured interviews, it is possible to identify that 41 out of 46 times the problem is presumably solved, and that means a rate of expected success of 89%. This way of interpreting the results allows to understand that the problems that were mentioned more times are expected to be solved.

Another conclusion that is possible to outline is that the non-solved problems were identified as meso problems (one of them) and micro problems (the other) Figure 30, so they are not the most critical ones. By other words it means that the two problems that were not mitigated by this proposal were not identified high important problems (Figure 54).

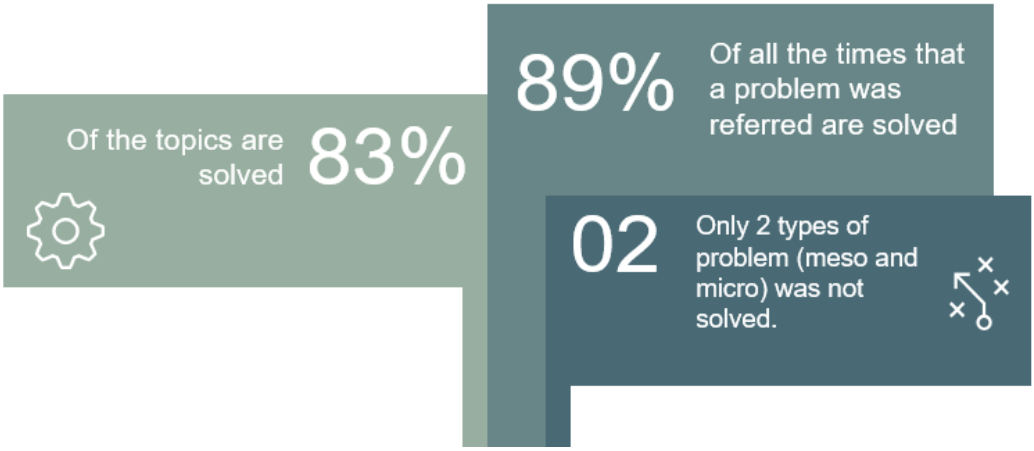

Figure 54 – Percentage of problems solved

To conclude, it is important to remember what is defined in section 1.2 about the main goals of this research, saying that the main objective of improving processes of project management was successfully achieved Table 9. All the tasks that were planned to be developed were done,

Table 9 - Comparation bewteen frameworks

	Old Framework	New Framework
Phases	6	6
Milestones	5	5
Project Charter	✗	✓
Stakeholders	✗	✓
Development	Waterfall	Iterative cycles
Closing phase	✗	✓
Activities	23 Processes	11 Processes

namely the identification of all past and undergoing processes for project management, mapping them, developing a standardized framework for project management processes and finally implementing the framework for ongoing and future projects. All the points that were expected to be achieved, with the work above described, were achieved.

7. CONCLUSION

This chapter has the main conclusions of the research project, as well as the main works that need to be implemented in other to complete the work.

7.1 Final Considerations

The main objective of this dissertation was to propose a new framework for project management, applying Lean Thinking principles in a logistics department of Bosch Car Multimedia.

In order to achieve this main objective, a strategy was developed (defined above in section 1.3.2).

The first thing to do was a study of the current management practices of the department, in order to understand its way of working and its heterogeneity. That study allowed the identification of different types of activities within the department, and the identification of an old framework that was used in the past for the management of projects but was no longer being used. Since the department operation was identified, it was time to look for the problems. In a nutshell, the strategy was firstly to map the process and the older framework, in order to reach and understand its problems and what lead to its disuse on the department. These identified problems lead to other more serious project management problems on the department due to the lack of guidance on this matter.

Having the problems well identified (using semi-structured interviews), and still before the proposal of a new framework, it was developed a suitability assessment study, in order to understand the degree of agility that the new framework should have. This agility need comes up after the possibility of adapting more traditional methodologies, or others that can be identified as Agile methodologies. With this study, it was possible to identify the right characteristics for the department framework.

With the problems and the agility identified, it was time to develop the first draft of the framework, and its application in the department. This first draft does not have all the important parts and analysis that are needed, since it is important to give time to align ways of work, however on other iterations, the proposals in future work chapter can be implemented.

However, it is possible to predict some results that the implementation of the framework may lead. It is expected that 83% of the main problems are going to be solved with the use of the framework.

It is possible to conclude that the main objective was reached, with a rate above explained of the problems being solved, and more importantly, with a new way of work implemented in the department.

7.2 Future Work

Like it was said earlier, the objectives of this study and the scope of this research, as well as the expected outputs, were attained, however there are some important next steps to assure and to maintain the viability of the framework.

One of the next steps is the adaptation of the general framework to each one of the four different types of projects. The framework created is a general framework, and it is from this one, that the four different types of projects, will have its own versions.

Other important task is the implementation of standard templates for the same documents. Here is going to be made an internal research on the mechanisms in the Bosch Group docupedia. The templates are, probably, the most important tool for the department users.

Another crucial tool that is needed, just like explained in section 5.4.4, is the long-term planning and control platform. This tool would bring a great level of organization and visibility within the department. For this, and as a suggestion is the adoption of the JIRA program platform from ATLASSIAN. This tool allows the allocation of capacities per team members in different projects, as well as the proper visibility of each time-schedule, backlogs, etc. It is also an online platform that brings agility into the project management processes to be implemented along with the framework.

The last thing that is proposed is the inclusion of a financial analysis during the entire project lifecycle, something that was not possible to implement due to the predictable lack of maturity of the framework proposed. It should be addressed when the framework assures the maintenance of the project effectiveness in order to develop the organizational efficiency.

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APPENDIX 1 – DATABASE TABLE

References	What is the relation between Lean Thinking and Project Management?	What Project Management methodologies were found on this research?
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Demir, S. D., Bryde, Dj, & Sertyesilisik, B. (2013). Introducing AgiLean to Construction Project Management. *Journal of Modern Project Management*, (3), 1. Retrieved from http://researchonline.ljmu.ac.uk/	+	-
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Holweg, M., & Maylor, H. (2018). Lean leadership in major projects: from "predict and provide" to "predict and prevent." *International Journal of Operations and Production Management*, *38*(6), 1368–1386. https://doi.org/10.1108/IJOPM-02-2017-0100	+	-
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Palmer, S., & Felsing, J. (2002). A practical guide to feature-driven development. Technical University of Munichical University of Munich.	-	+

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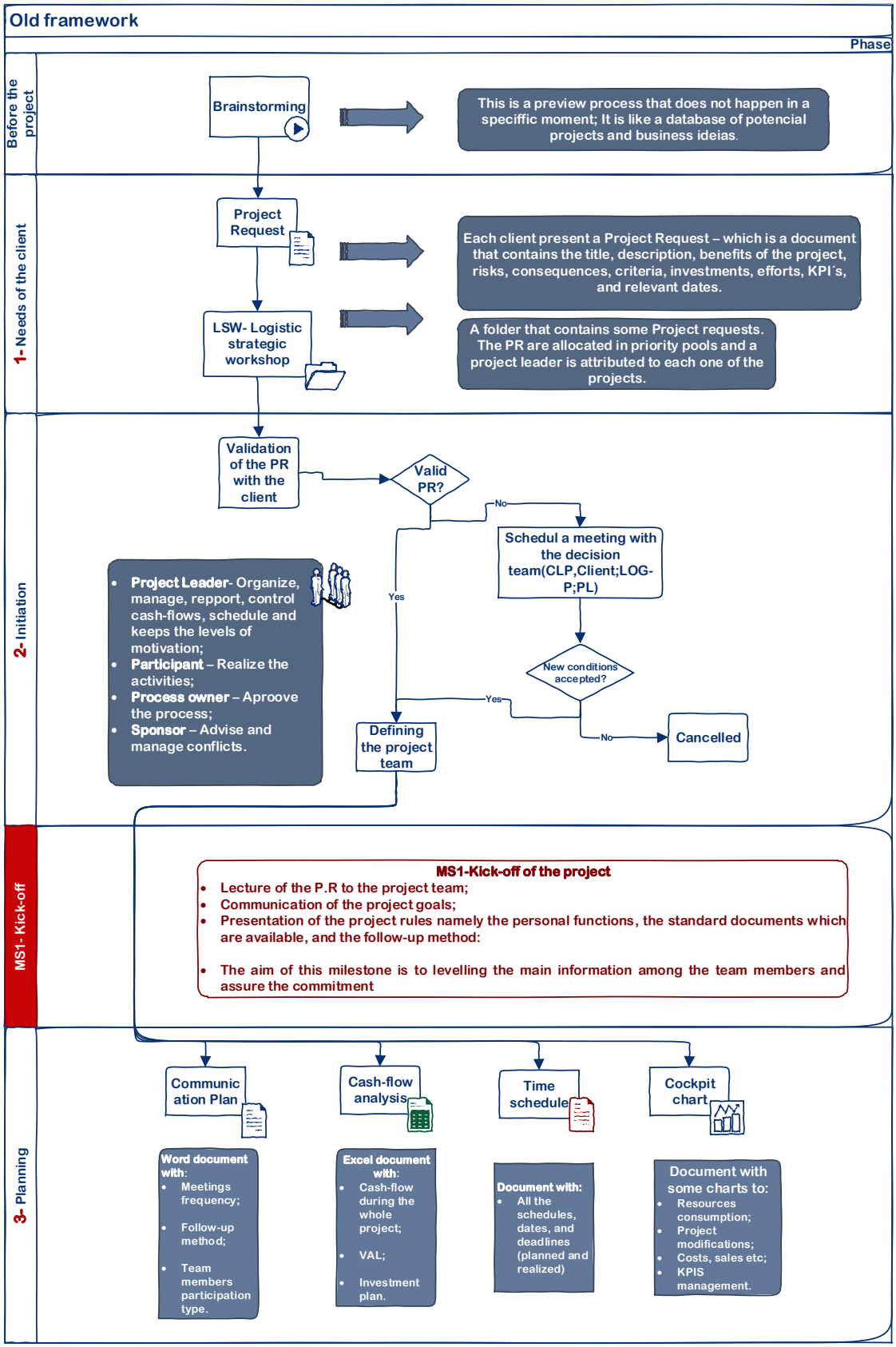
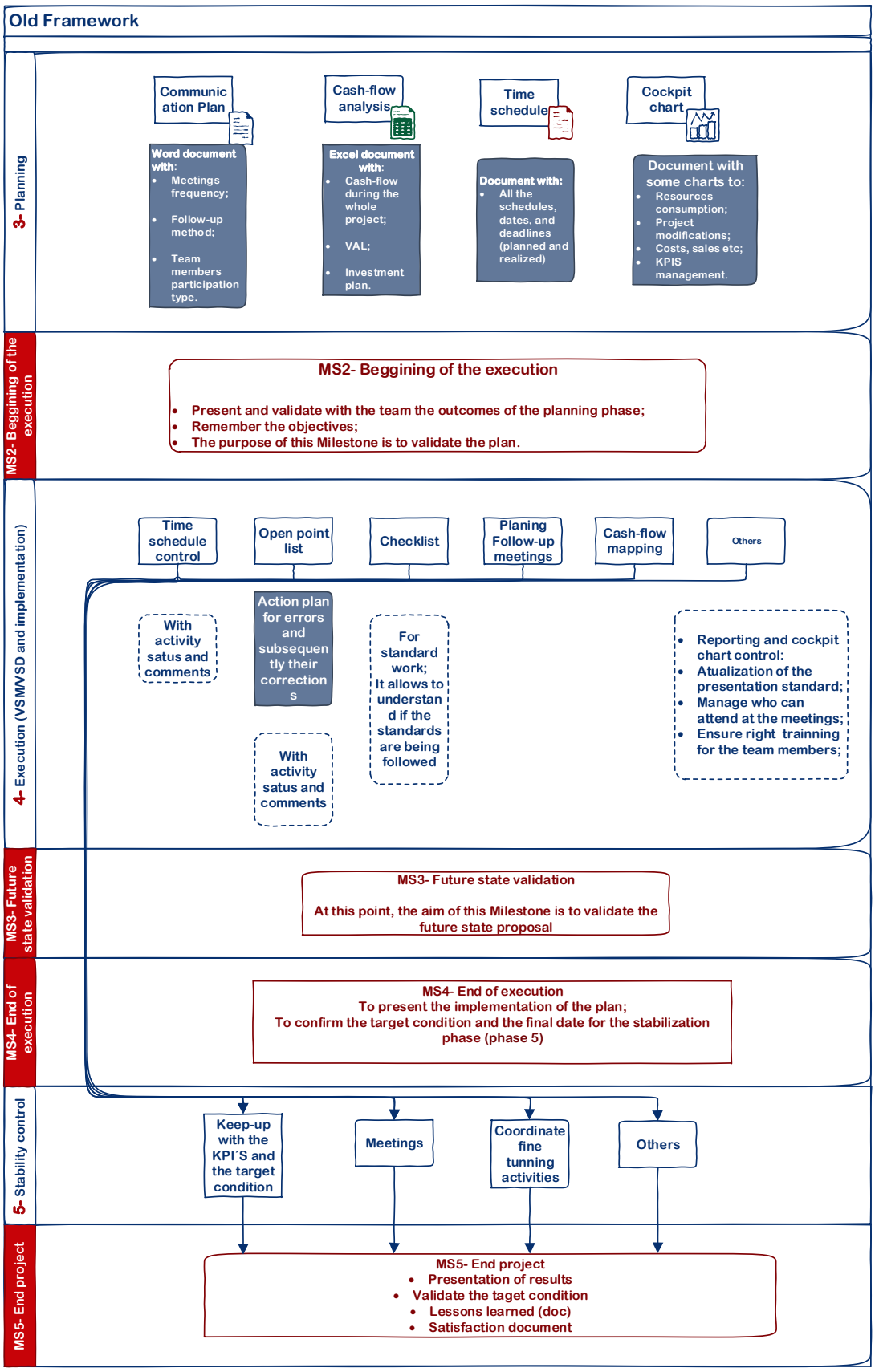
APPENDIX 2 – OLD FRAMEWORK




Old Framework
3- Planning
Communication Plan
Word document with:
Meetings frequency;
Follow-up method;
Team members participation type.
Cash-flow analysis
Excel document with:
Cash-flow during the whole project;
VAL;
Investment plan.
Time schedule
Document with:
All the schedules, dates, and deadlines (planned and realized)
Cockpit chart
Document with some charts to:
Resources consumption;
Project modifications;
Costs, sales etc;
KPIS management.
MS2- Beggining of the execution
MS2- Beggining of the execution
Present and validate with the team the outcomes of the planning phase;
Remember the objectives;
The purpose of this Milestone is to validate the plan.
4- Execution (VSM/VSD and implementation)
Time schedule control
With activity satus and comments
Open point list
Action plan for errors and subsequently their corrections
With activity satus and comments
Checklist
For standard work;
It allows to understand if the standards are being followed
Planing Follow-up meetings
Cash-flow mapping
Others
Reporting and cockpit chart control:
Atualization of the presentation standard;
Manage who can attend at the meetings;
Ensure right trainning for the team members;
MS3- Future state validation
MS3- Future state validation
At this point, the aim of this Milestone is to validate the future state proposal
MS4- End of execution
MS4- End of execution
To present the implementation of the plan;
To confirm the target condition and the final date for the stabilization phase (phase 5)
5- Stability control
Keep-up with the KPI´S and the target condition
Meetings
Coordinate fine tunning activities
Others
MS5- End project
MS5- End project
Presentation of results
Validate the taget condition
Lessons learned (doc)
Satisfaction document

APPENDIX 3 – INTERVIEWS TEMPLATE

Template entrevistas

O seguinte guião tem como objetivo servir de base para a próxima fase do projeto de dissertação que estou a desenvolver. Nesta fase será feita uma recolha de dados sobre a gestão de projetos do departamento de LOI.

O método de entrevista será semi-estruturado, portanto apesar de se tentar seguir as questões base abaixo mencionadas, questões que podem surgir durante as entrevistas serão consideradas.

1. **Identificação do projeto**
    a. Nome do projeto(s):
    b. Objetivo/Outputs do projeto:
    c. Tipologia de projeto (ex: desenvolvimento de software, implementação de software…):
    d. Quais as fases que o/os projeto(s) foram realizadas:
    e. Data de início:
    f. Data prevista de fim:
    g. Data de fim:
    h. Project Leader e Team members:
2. **Problemas associados**
    a. Projeto correu como esperado?
    b. O que falhou?
    c. Em que fase (ex: Iniciação, planeamento, conclusão…)?
    d. Ferramentas de controlo usadas e qual o seu propósito:
    e. Maiores dificuldades sentidas?

f. Que ferramenta faltou (ex: cockpit chart, OPL…)?

g. Em que fase faltou?

h. Burocracia e desorganização de documentos (ex: excesso de pastas com a mesma informação)?

i. Se tivesse que criar uma ferramenta de apoio ao projeto qual seria/ em que consistiria?

3. **Comentários adicionais/ Dicas para o projeto:**